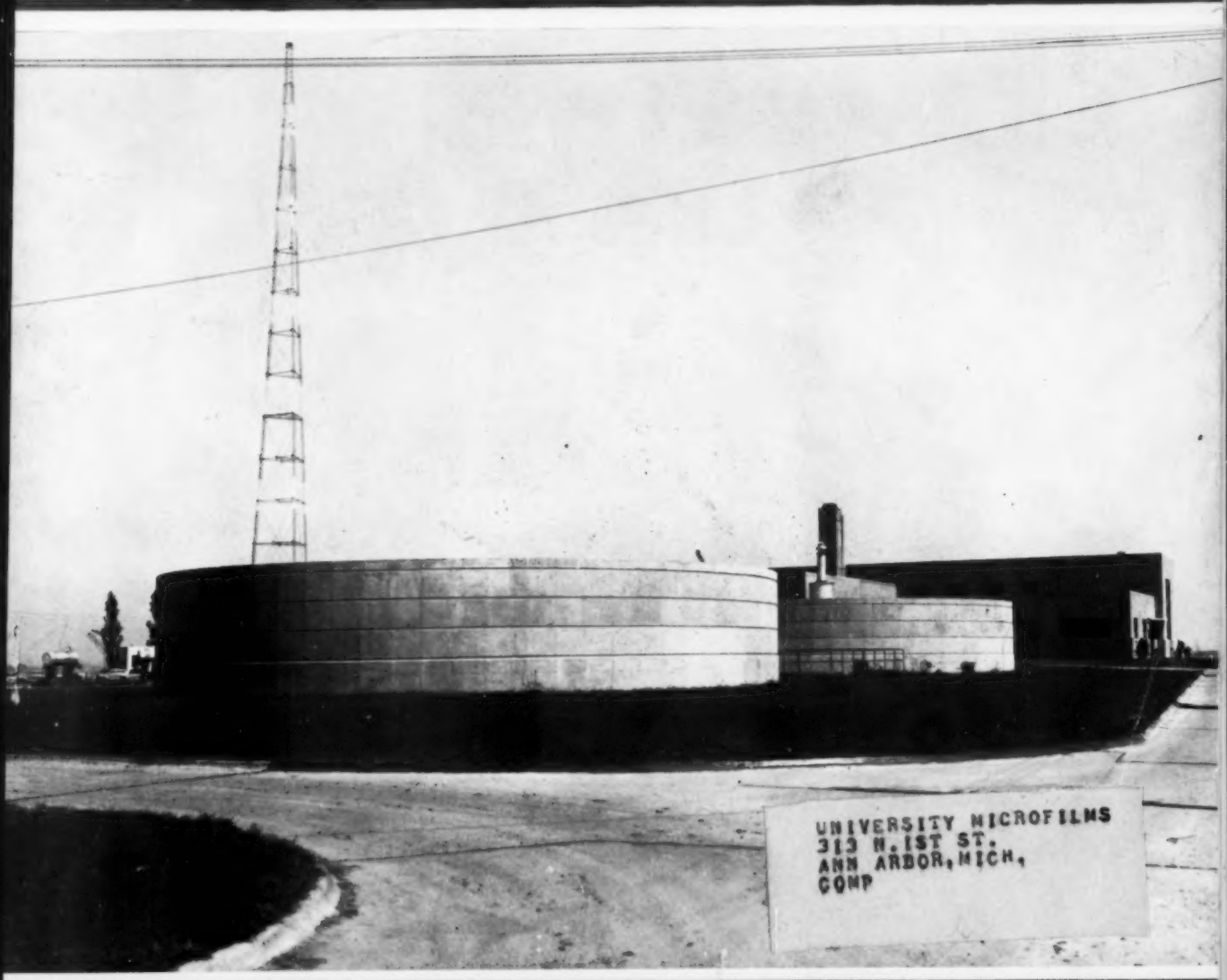
WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

A Scranton Gillette Publication



UNIVERSITY MICROFILMS
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ANN ARBOR, MICH.
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AUGUST
1957

"Watch Your CO_2 Line", and avoid digester headaches 362
Fundamentals and basic considerations in water softening 327
An improved sewage flow measuring unit 366
Removal of immediate oxygen demand from supernatant 374

Plug rotates as journal

Smooth bearing-surface in body

acf Cylindrical Plug Valves for easy, positive action

bearing-smooth operation.. PLUS A TIGHT SEAL

acf® LUBRICATED CYLINDRICAL PLUG VALVES

The cylindrical plug of your acf valve fits and turns in the valve body with the same ease and smoothness as a shaft in a journal bearing. The plug rides freely on a film of lubrication to provide a tight seal without binding.

A patented head gasket, made of Teflon*, is backed by the lubricant and provides a dead-tight head seal. Self-lubricating Teflon reduces friction between plug and body at the head to further minimize turning torque.

When you specify acf Lubricated Plug Valves in new—or replacement—installations you will save money initially, and later on repairs and maintenance.

acf valves are available in semi-steel, carbon steel, bronze, and aluminum.

Ask your Industrial or Mill Supply Distributor for acf *Valves.*

Sizes: ½" through 30".

Pressures: Semi-steel; 175 lbs. WOG to 500 lbs. WOG. Carbon steel; ASA 150 and ASA 300.

acf *Rectangular Port Valves in pump room of California sewage disposal plant.*

W-K-M

DIVISION OF acf INDUSTRIES INCORPORATED

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MAILING ADDRESS: P. O. BOX 2117, HOUSTON, TEXAS

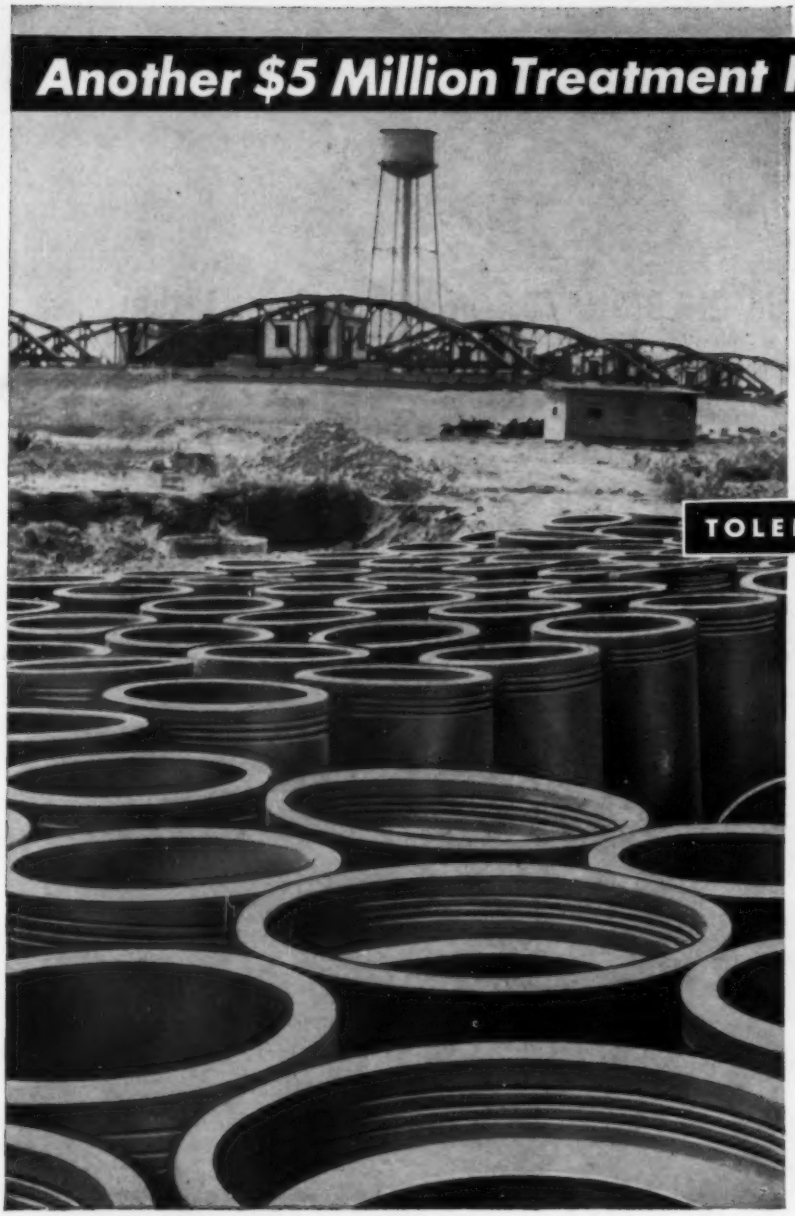
Write Dept. S-8 for new ACF Valve Catalog 400.

8706

MANUFACTURERS OF W-K-M GATE VALVES acf LUBRICATED PLUG VALVES
KEY-KAST ALLOY STEEL PIPING FITTINGS KEY RETURN BENDS AND FITTINGS

*DuPont's tetrafluoroethylene resin. acf is a registered trademark of acf Industries, Inc.

Another $5 Million Treatment Plant Expansion



...WITH CLAY PIPE ON THE JOB!

TOLEDO, OHIO is keeping abreast of the needs of its growing population with a $5 million bond financed program for expanding and modernizing its sewage treatment facilities. Work on this two-year project is underway now, and one of the first materials on the job was *Clay Pipe* for utility lines.

Why Clay? Because it's chemically inert—completely impervious to corrosives that damage ordinary pipe. It can't rust or rot . . . can't corrode or disintegrate. Its slick vitrified surface insures faster flow, with no chance for waste deposits to build up. Important, too, is its *exclusive long-term guarantee* —positive assurance of protection until years after the last revenue bond has been retired.

When *your* community plans new sewerage facilities, remember these important features. Guard the long-term investment by specifying Clay Pipe.

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Arthur H. Niles, *Sewage Disposal Commissioner*
Consulting Engineers: Consoer, Townsend & Associates
Contractor: Rust Engineering Co.

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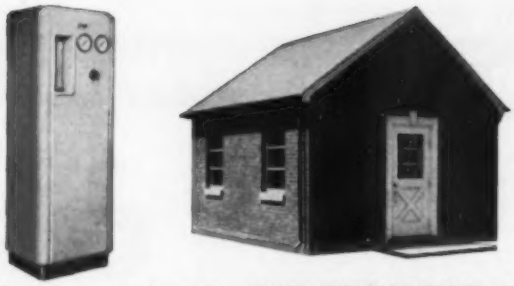

from a simple CHLORINATOR in a pumping station

to a complete CONTROL SYSTEM in a multi-million dollar plant

for water, waste, and sewage treatment

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WATER SUPPLY • SEWAGE DISPOSAL

Vol. 104 No. 8

AUGUST 1957

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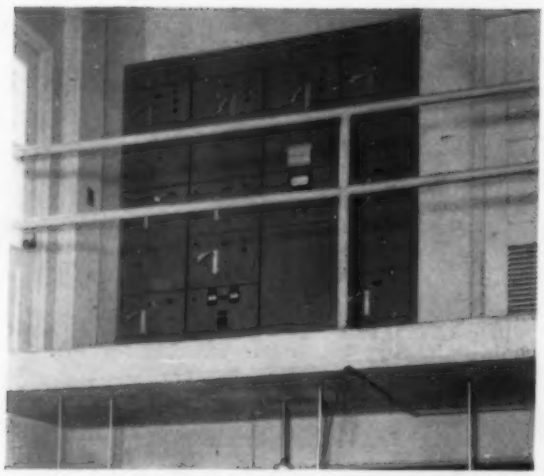
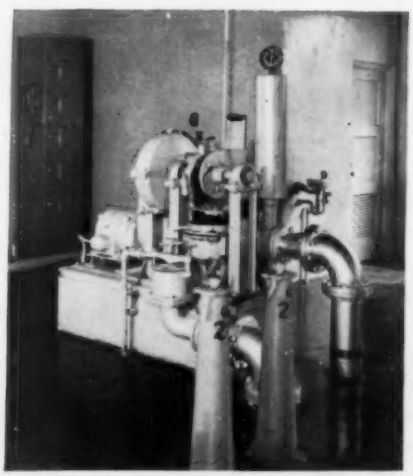


Control center for many of the sewage plant motors, located on a balcony to conserve space, is typical of the Westinghouse unitized equipment which simplifies sewage plant electrical construction.



This Westinghouse motor drives one of the many pumps in the treatment plant. Note convenient location of control unit for this and other adjacent motors.

78 cents per million gallons... pumped by Westinghouse

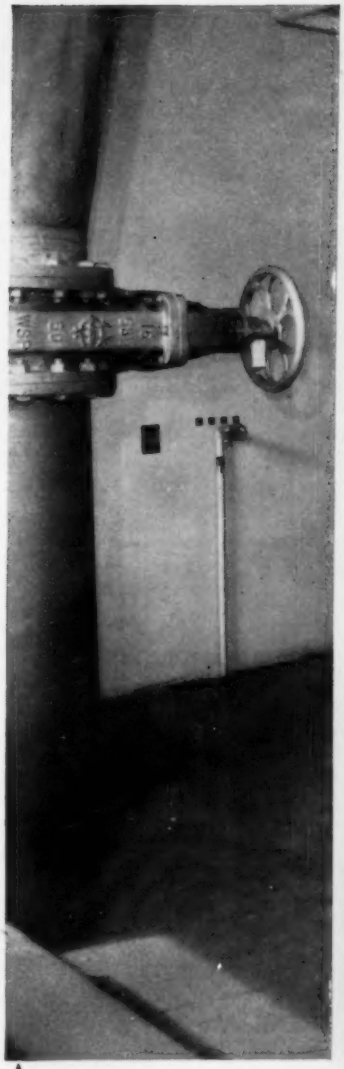
Basic operating cost of pumping stations in the Tacoma, Washington, sewage plant is of more than usual importance in the over-all plant cost because of an unusually high gallons-per-capita-day flow through the system. Engineers found it necessary to plan for nearly three times normal.

In the main pumping plant at Tacoma, four Westinghouse vertical pump motors handle the load. They are cut in and out as required and the sequence of rotation changed automatically. The station is unmanned except for periodic checks and maintenance by operators from the treatment plant.

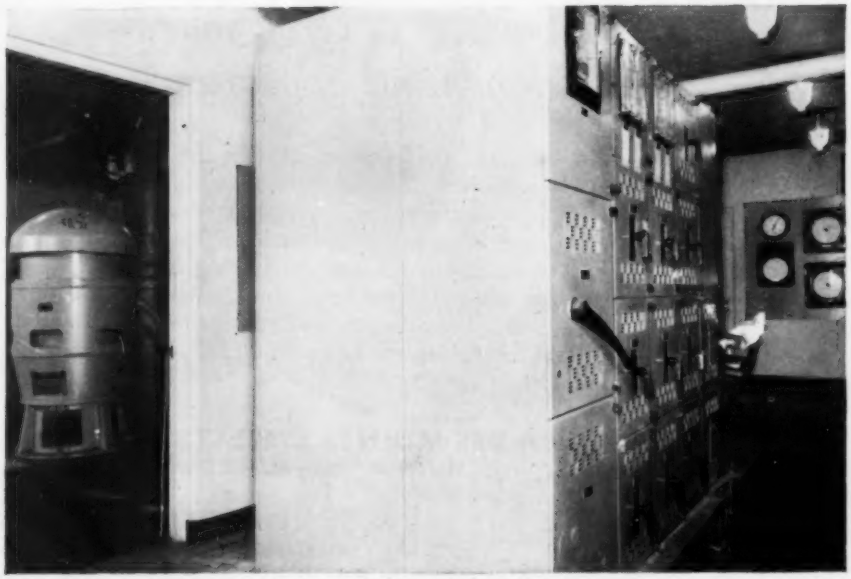
Although the pumping requirement is high in proportion to the population served (about 67,000) the actual pumping cost is not. Yearly costs in the Tacoma plant average about 78 cents per million gallons of sewage pumped. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. J-94075

YOU CAN BE SURE... IF IT'S

Westinghouse

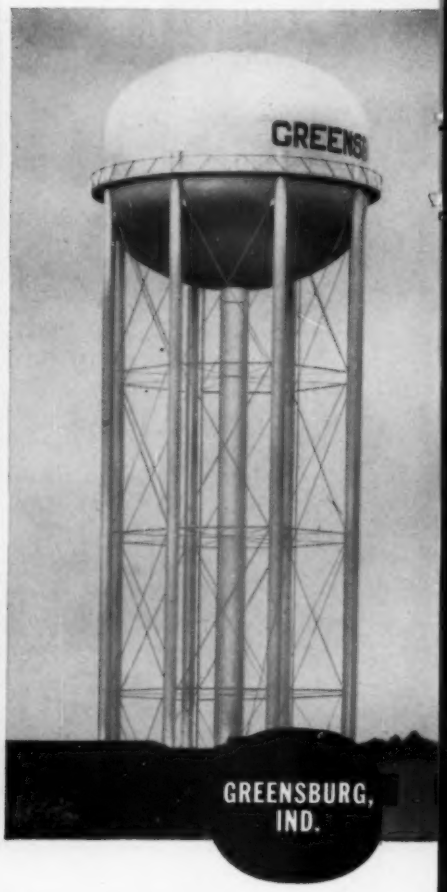


The four Westinghouse vertical pump motors in the Tacoma plant—4000 gpm, 50 hp; 8000 gpm, 100 hp; 10,000 gpm, 100 hp; 12,000 gpm, 125 hp.



Distribution of power to motor and lighting circuits for the entire plant is through this Westinghouse switchgear, located in the main pump building.

50,000 Gallons | **150,000 Gallons** | **500,000 Gallons**



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Safety costs millions — and they're dollars well spent. But reckless spending of water can destroy any community. If the situation is not already critical in your area, chances are in a few years it will be. Take the first logical step now toward water conservation, with Badger meters . . . the fair-sharing way to make consumers aware of water cost, sharply reduce waste and build water revenue.

Badger disc, turbine and compound meters are adaptable to all local needs and water conditions. An example of Badger leadership is their exclusive compound meter which handles fluctuating water demands of factories, schools, theatres and apartment buildings—wherever the rate of flow varies through the day. Badger compound meters, like all other water meters in this complete line, assure maximum utility with full honest revenue.

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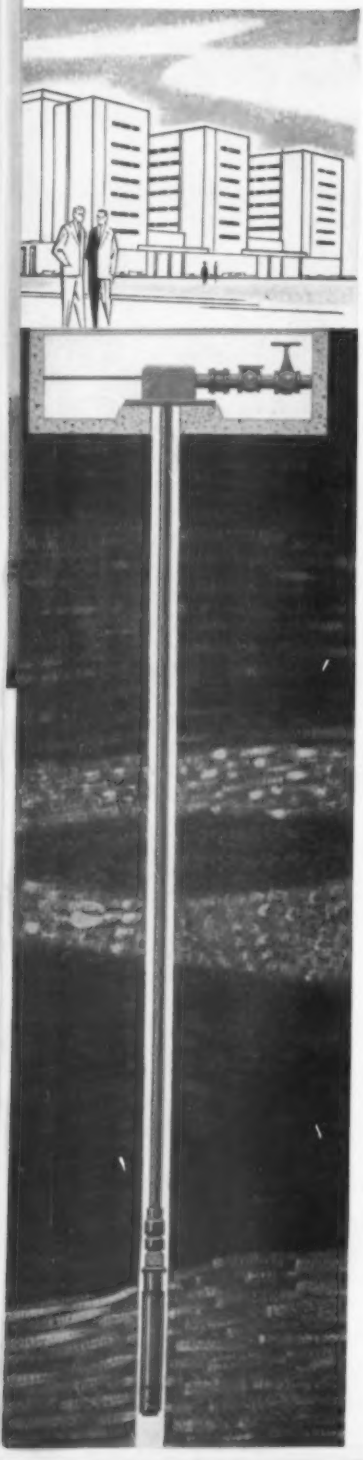

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Now you can have all the advantages of a submersible pump, plus time- and performance-tested Fairbanks-Morse features.

Fairbanks-Morse submersible pumps permit well location anywhere that a well can be drilled. No unsightly installations, no costly pump housing. Nothing—absolutely nothing—need show above ground. These pumps submerged in the well below water level are practically soundless and require no line shafts, packing boxes or lubrication devices. Hence, wearing parts needing maintenance are reduced to a minimum. A single moving assembly does all the work.

Installation is faster and more economical. The Fairbanks-Morse motor, with lifetime Copperspun rotor cooled by water and lubricated by water, gives full motor output. The well-known Fairbanks-Morse or Pomona pump bowls are combined with these wet stator motors to produce unbeatable pumping units covering a wide range of requirements as to volume, pressure, and setting depth.

For industry or community service you can place your water service trust in the F-M submersible. Contact your Fairbanks-Morse Sales Engineer and ask him for Bulletin 6910 on this time-proved submersible pump, or write today to Fairbanks, Morse & Co., Dept. WSW-8, 600 S. Michigan Avenue, Chicago 5, Illinois.

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a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY
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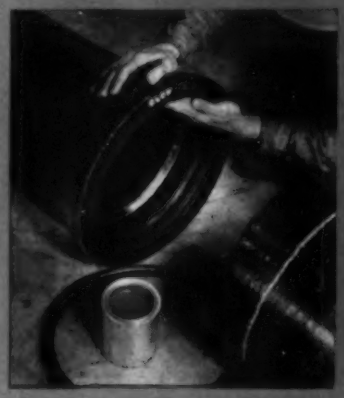
CLOW BELL-TITE CAST IRON PIPE

costs less to buy, less to lay!



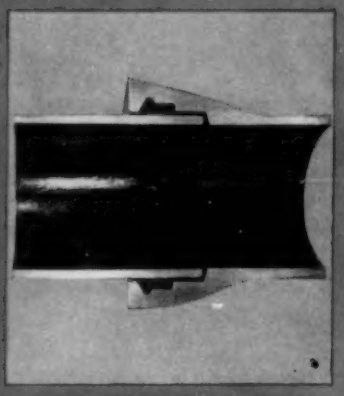
Assembly is simple. First, the joint is wiped clean.

Second step — insert gasket as shown into groove in bell.

Third — apply thin film of special lubricant to the gasket.

Next—push home the spigot, first centering plain end in bell.

No bell holes are required. Installation is very rapid.



Result—a safe, economical joint with a tight, permanent seal.

The NEW CLOW BELL-TITE cast iron pipe joint is a rubber seal joint that requires NO bolts, NO nuts, and requires NO wrenches to lay. It takes less time to install. It costs less to buy. Here's economy PLUS.

The Underwriters' Laboratories, after testing the joint, have approved its use for water working pressures up to 350 psi. CLOW BELL-TITE pipe barrel meets all quality provisions and physical requirements of all applicable ASA, AWWA, and/or Federal Specifications for cast iron pipe.

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Subsidiaries: Eddy Valve Company, Waterford, New York • Iowa Valve Company, Oskaloosa, Iowa

Protect YOUR

USE MUELLER® COPPER

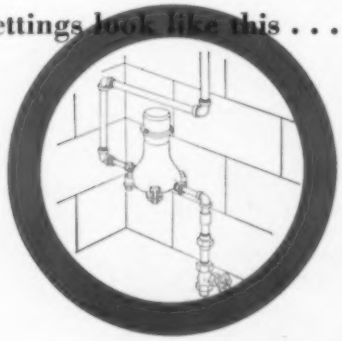
Mueller Copper Meter Yokes give strong, permanent settings for your water meters quickly and easily. Installation time is reduced to a minimum and fittings are practically eliminated.

Ribbed body absorbs piping stresses without transmitting them to the meter. Meters are protected to insure accurate measurement and full revenue.

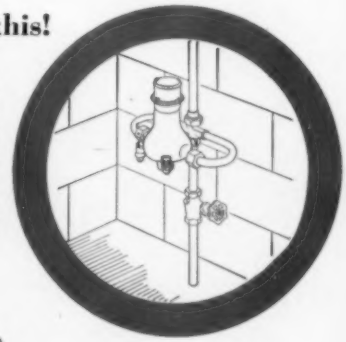
Properly spaced and aligned swivel nuts make meter changes for testing and maintenance a cinch. Pipes are not disturbed and replacement is fast and easy. Swivel nuts are drilled for wire seal, too.

And Mueller's special, multi-purpose end connections give you a choice of outside I.P., inside I.P., copper or any combination of these connections just by changing tailpieces.

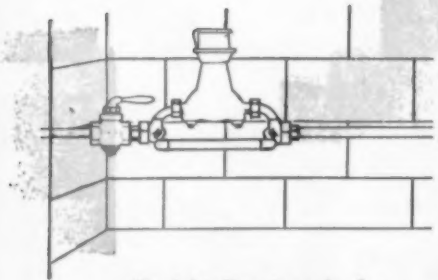
If your meter settings look like this . . . . . try this!



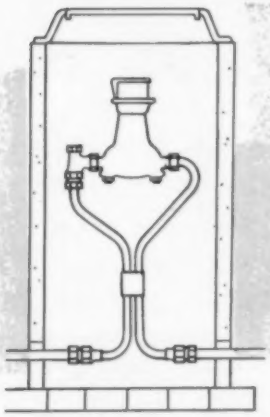
Save time, fittings and pipe in basement meter settings by installing a Mueller Copper Meter Yoke specifically designed for basement settings. A tailor-made setting for your meter at right angles to the service line is quickly completed.



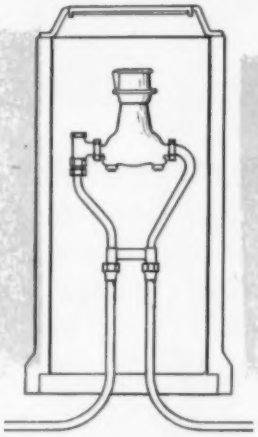
a COPPER *Meter Yoke for any installation!*



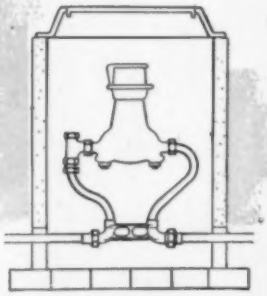
Straight line type is designed for indoor settings where meter cannot be raised or for outdoor use with shallow lines.



Flexible inlet and outlet of this yoke make it easy to install where pipes are out of line and connections are difficult to make. Also available for pipes at different levels, for angle settings or extended for connections outside of box.



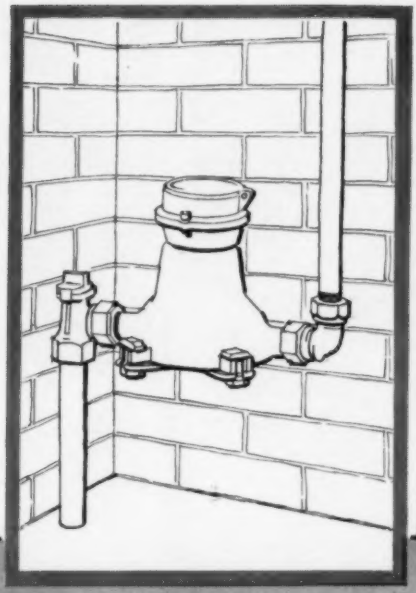
Vertical inlet and outlet type makes it possible to use regular outdoor meter box for deeply-buried lines.



Horizontal inlet and outlet type is used for outdoor meter box settings where service line is buried at medium depth.

WATER METERS...

METER YOKES!



And if you cannot use a meter yoke . . . use a

MUELLER *Angle Meter Stop!*

An ideal setting for extremely confined locations where there is not enough space for a yoke or stop, is a Mueller Angle Meter Stop and Meter Coupling. Setting is made quickly and no other fittings are needed.

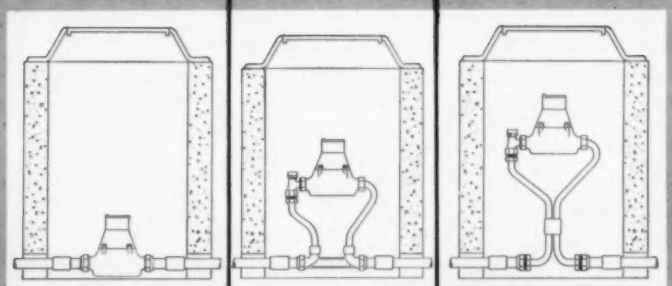
Install Copper Meter Yokes in your existing services without changing piping or fittings!

Mueller Copper Meter Relocater Yokes are easily installed in place of present meters without disturbing original fittings or piping in any way.

Yoke body is the same length as meter and inlet and outlet connections have standard meter spud threads. Meter is raised above dirt and water in meter box and made much easier to read or change. And flat head or lock wing stop may be included right in the yoke.

Flexible Copper Meter Relocaters make it easy to raise meters even when pipe has shifted out of line or moved closer together or farther apart. The flexibility of the connections is not transmitted to the upper portion of the yoke and spacing for meter is unaffected.

. . . see your Mueller Representative today!



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Mr. Evan Evans (right) and Mr. Clarence Dankel (left)

"Our 30-in steel pipe is going strong after 25 years"

(Report of an interview with Evan Evans, president, and Clarence Dankel, general manager, Panther Valley Water Company, Lansford, Pa. In 1932 this company constructed a 30-in.-ID steel pipe line nearly 10 miles from Still Creek dam to Coaldale. The pipe was fabricated in 30-ft lengths by Bethlehem Steel Company. It was lined with 3/32-in.-thick Bitumastic enamel, and is thought to have been the country's first large steel water main to be enamel-lined centrifugally. Engineers were Gannett, Seelye & Fleming, now Gannett, Fleming, Corddry & Carpenter, Inc., Harrisburg, Pa.)

Q. Mr. Evans, is the Still Creek line in service today?

A. Yes, it's been used continuously since 1932, carrying about 15,000,000 g.p.d.

Q. How about the flow capacity?

A. The average "C" as determined by our flow tests in 1933 and in 1940 was about 145. I'd say that the flow capacity is just about as good as ever today. There has been no damage to the tar enamel lining as far as I know.

Q. Has the pipe ever failed in any way?

A. No, and it's quite amazing. During the flood caused by hurricane Connie in 1955 the cover was completely swept away from about 1000 ft of the pipe. In many places the pipe spanned 50 or 60 ft without any support whatsoever. Yet there wasn't even the trace of a failure. What's more, the line runs right through our worst areas of subsidence due to mine cave-ins. Still no trouble with the pipe.

Q. What kind of soil is the pipe laid in?

A. Just about the worst you could find. It's "hot" soil; lots of coal banks and the like. But it hasn't damaged the pipe.

Q. Then you're satisfied with performance of the line?

A. Definitely. We're well pleased in every respect.

Would you like to have more information about Bethlehem Tar-Enameled Steel Pipe? Please contact the Bethlehem sales office most convenient to you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

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BETHLEHEM STEEL

BETHLEHEM STEEL

Latest additions to the Darien, Connecticut, plant include a new digester (left), and P.F.T.—Pearth equipment on the existing cover. Design of plant by: Bogert & Childs, Consulting Engineers, New York City.

Plant expands, and P.F.T. equipment is selected for the third time

For the third time, Darien, Connecticut, has selected P.F.T. equipment for digester additions and improvements. This city knows there is no substitute for well engineered, thoroughly dependable equipment.

P.F.T. supplied dosing siphons in 1927, floating cover and gas safety equipment in 1939, and now a Gas Holder Cover for the new 30-foot digester. A complete P.F.T.—Pearth Gas Recirculation System was also installed on the existing 30-foot cover. Now scum conditions are closely controlled, and the entire tank can be used for active sludge digestion.

In addition to floating cover, gas holder, and Pearth system, the plant includes a gas-oil fired P.F.T. #100 Sludge Heater, and a complete complement of Gas Control Equipment.

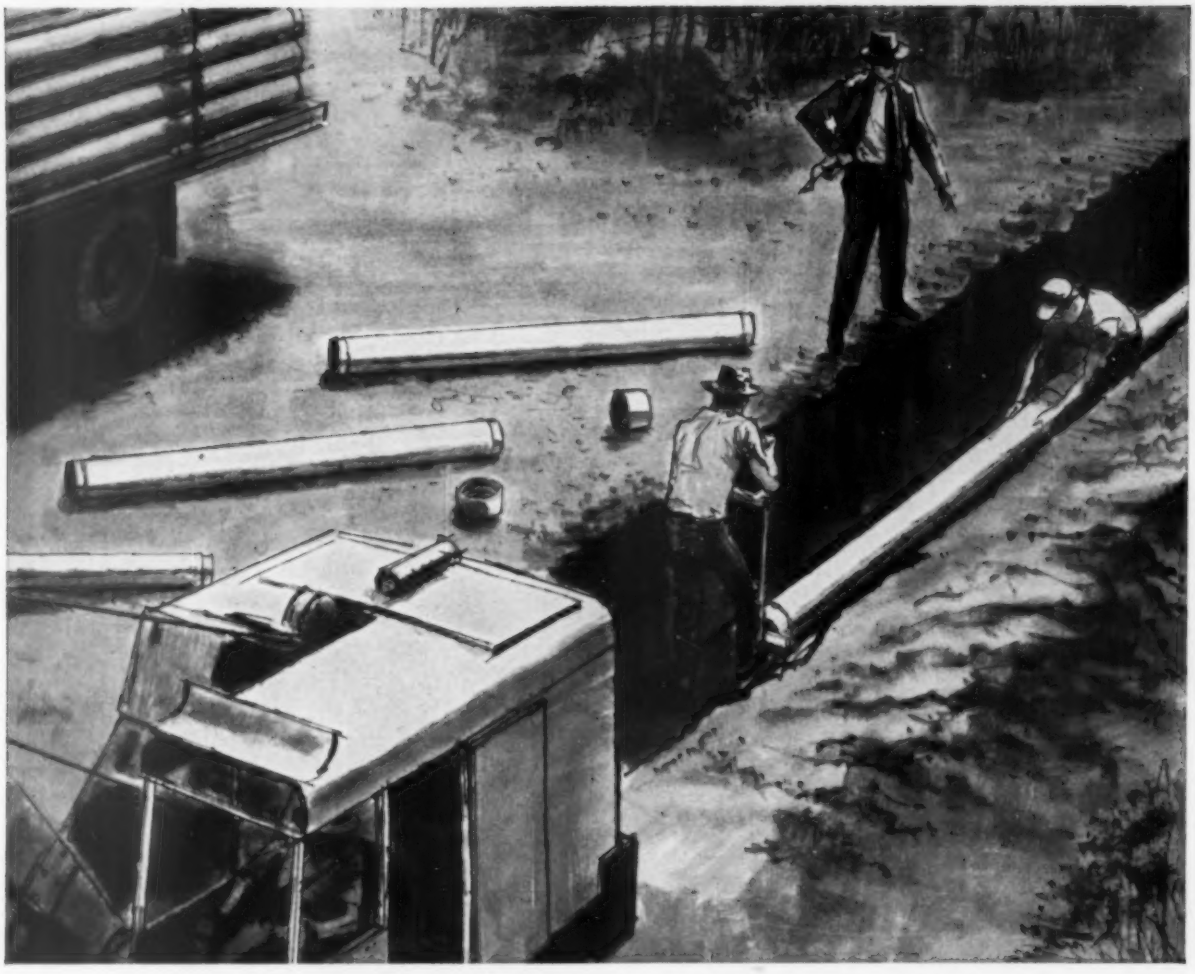
For additional information about efficient, dependable P.F.T. equipment and methods, write today for Bulletin No. 300.

waste treatment equipment exclusively since 1893

P.F.T.

PACIFIC FLUSH TANK CO.
4241 Ravenswood Avenue
Chicago 13, Illinois

PORT CHESTER, N. Y. • SAN MATEO, CALIF. • CHARLOTTE, N. C. • JACKSONVILLE • DENVER



The job moves along fast
with Transite and the Ring-Tite Coupling!

Sectional view of Ring-Tite Coupling. Ring is cut away to show how rings are compressed and locked in grooves—*a tight, lasting seal!*

Transite Pressure Pipe is lightweight and easy-to-handle . . . quickly assembled with the Ring-Tite Coupling!

With Transite® Pipe, installation crews move along fast! So fast, they consistently keep up with the excavator—installing pipe as rapidly as the trench can be opened.

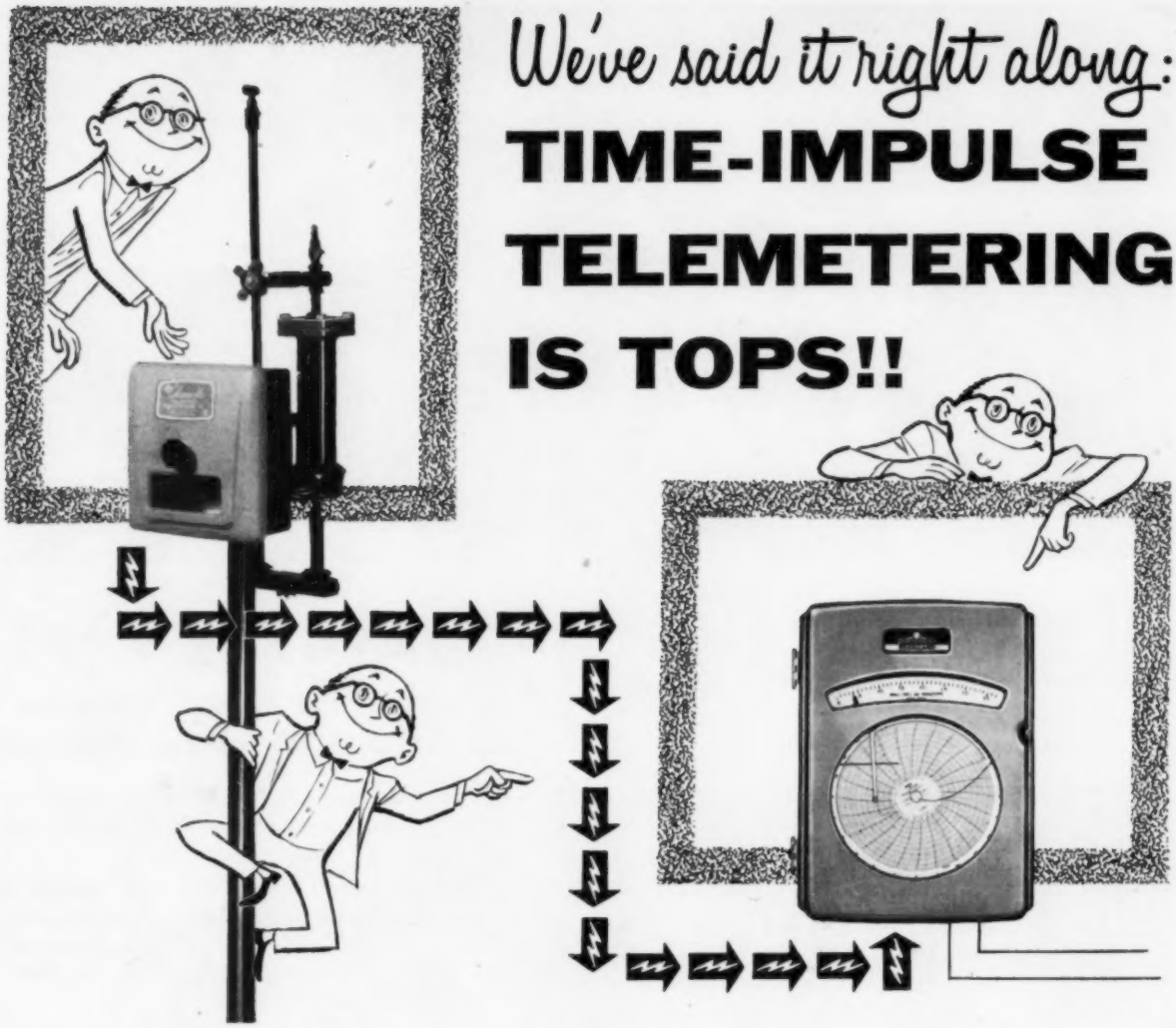
Ease of handling and simplified assembly explain these advantages. Light in weight, Transite is easier to truck, easier to handle on the job. With the Ring-Tite® Coupling only simplest tools are needed for joining—pipe ends are automatically positioned within the coupling to allow for expansion.

So save while you assure your community of top economy, long trouble-free performance with Transite. For its smooth interior (flow coefficient is C=140) *often* permits selection of smaller diameter pipe . . . *always* keeps pumping costs low. And since Transite can't tuberculate, water systems can be designed without allowing for future flow reduction caused by that form of interior corrosion.

Let us send you further information on Transite asbestos-cement Pressure Pipe and the Ring-Tite Coupling. Write for booklet, TR-160A, Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE PRESSURE PIPE



We've said it right along:

TIME-IMPULSE TELEMETERING IS TOPS!!

. . . AND YOU'VE SAID IT TOO . . . WITH YOUR ORDERS!!

In Builders Chronoflo Telemetering Systems: The transmitting and receiving reactions depend only upon the *positively* controlled duration of regular electric circuit closures and *nothing* more. **The Telemeter** is a pure, *positive-action* positioning system.

- It *does not* have to *translate* units of electric measurement into terms of rate of flow or other factors measured.
- It requires *no* relatively delicate electric components.
- It *doesn't employ* a series of contact rods "shorted out" by step-by-step action of rising mercury.
- It is *not affected* by normally encountered induced voltages.
- Receiver *accuracy not affected* by room temperature, line pressure, duration of "down time", and similar factors.

The Chronoflo Receiver is *not* inferentially positioned except respect to time duration of the Transmitter signals.

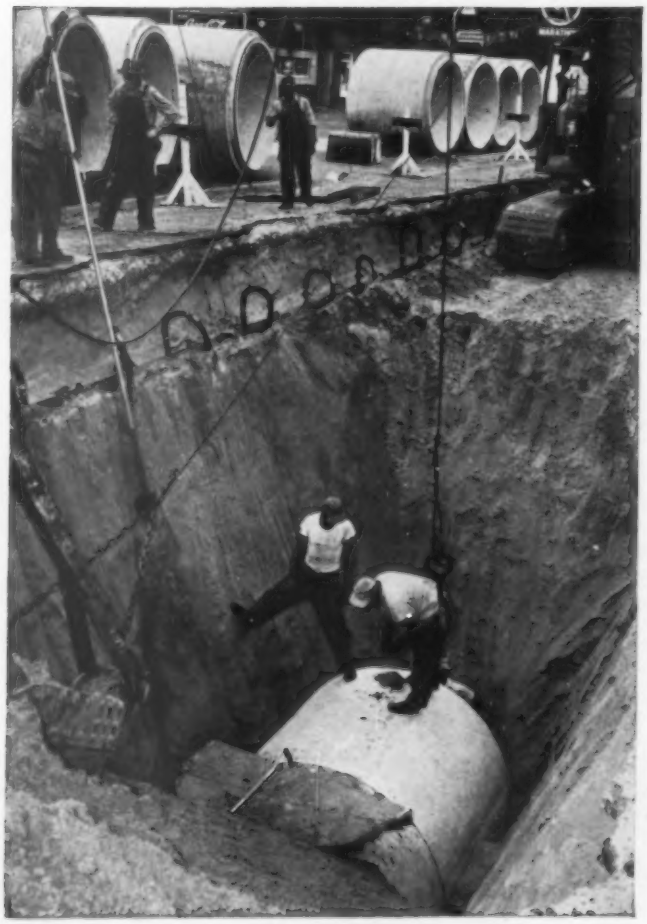
These are *only a few* reasons why time-impulse telemetering is "Tops". Let the company which pioneered this system over 25 years ago and has the experience gained in engineering thousands of installations give you complete proof of its dependability and accuracy.

Request Bulletin 230-H4A. Write Builders-Providence, Inc., 350 Harris Ave., Providence 1, R. I.

BUILDERS-PROVIDENCE
DIVISION OF
B-I-F INDUSTRIES
METERS FEEDERS CONTROLS

Above: South Broadway Interceptor
Below: Tolleston Area: Chase Interceptor; 25th Street Interceptor
Engineer: Hurst-Roche, Inc., Hillsboro, Ill.
Contr.: Witter-Gaddis Constr. Co., Schererville, Ind.

Rhode Island Interceptor (not shown)
Engineer: Hurst-Roche, Inc.
Contractor: Marsch Construction Co., Chicago



CONCRETE PIPE

chosen for Gary, Indiana $6,000,000 Sewer Project

To meet the needs of its expanding population, Gary, Indiana has invested $6,000,000 in new concrete interceptor and relief sewers.

The first project, a $2 million job, consisted of (a) an interceptor on Rhode Island Avenue using reinforced concrete sewer pipe ranging from 96″ to 132″ in size and (b) an interceptor on South Broadway requiring over a mile of concrete pipe ranging from 24″ to 84″.

The second project, the Tolleston Area: Chase Interceptor; 25th Street Interceptor, was a $4 million job. The Chase Interceptor required about 2 miles of reinforced concrete sewer pipe from 60″ to 132″ in diameter. The 25th Street Interceptor required one and one-half miles of concrete pipe ranging from 24″ to 84″ in size.

The 132″ pipe was the largest ever installed in northwest Indiana. Both projects were financed by bond issues.

Countless cities have learned that concrete pipe has rugged durability and great structural strength. It offers maximum hydraulic capacity, minimum infiltration and leakage and exceptional resistance to abrasion.

Concrete pipe sewers are moderate in first cost, require very little maintenance, and give a lifetime of faithful service. The result: *low annual cost.*

PORTLAND CEMENT ASSOCIATION
33 West Grand Avenue, Chicago 10, Illinois
A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work

As Hinsdale, Illinois grew,—so did their water requirements.

A hot, dry summer in 1953 and an active and creative Village Plan Commission resulted in plans for this ornamental 2,000,000-gallon Horton® standpipe which was fabricated and erected by CB&I. The shell was painted pea green, the ribs a forest green and the roof a cloud grey. The 99½-ft. high structure now rises from a landscaped high point in Hinsdale —to provide dependable gravity pressure water supply for the village needs.

Steel water storage structures, of standard or special design are a specialty *and an art* with CB&I. Four strategically located CB&I plants are fully equipped and experienced to meet *your* most specific requirements. Write our nearest office for details.

Hinsdale's 60-ft. diam. by 99½-ft. high ornamental standpipe was fabricated in our Chicago plant. Plates were pickled and painted before shipment to resist corrosion, provide better paint bond, and reduce maintenance.

Alvord, Burdick & Howson—Consulting Engineers.

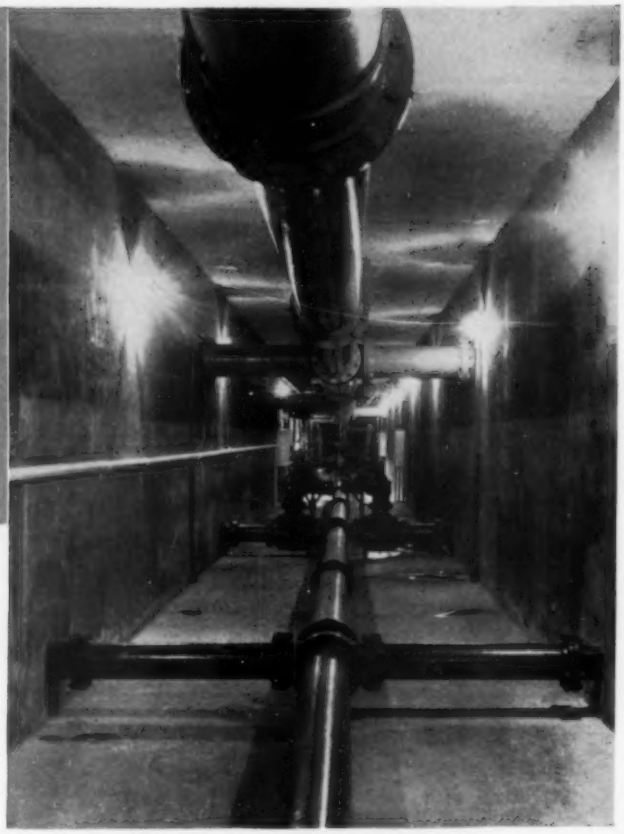
CB&I

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • South Pasadena • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

M39

Designed to meet modern requirements



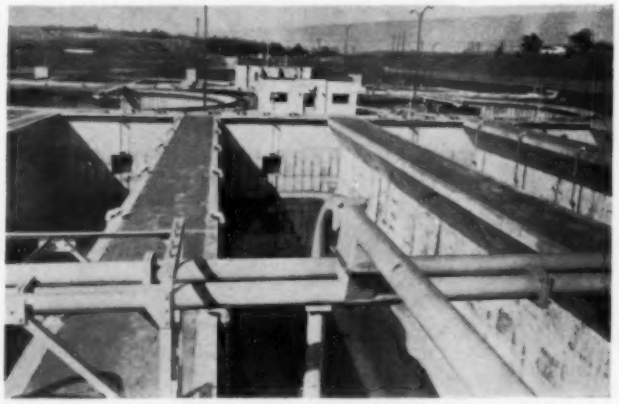
Pipe gallery with sludge suction, scum, and drain piping from primary clarifiers. American Cast Iron Pipe and Fittings.

AMERICAN CAST IRON PIPE

Modern plant design incorporates both efficiency and economy. That's why piping in the $1,500,000 Village Creek Sewage Treatment Plant of Jefferson County, Alabama, is American Cast Iron Pipe.

The high flow capacity, strength, and resistance to corrosion of American Cast Iron Pipe contribute to efficient operation of any modern plant. Its long, trouble-free service life adds the assurance of economy, as well.

Get in touch with your American Cast Iron Pipe Company representative while your new plant or addition to an existing system is in the planning stage. You'll find his up-to-the-minute knowledge of modern methods and materials helpful.



Aeration tank, metering station and primary clarifiers at Village Creek Sewage Treatment Plant, Pratt City, Alabama.

SALES OFFICES New York City • Chicago • Kansas City • Minneapolis • Cleveland
Dallas • Los Angeles • San Francisco • Orlando • Pittsburgh • Denver

AMERICAN CAST IRON PIPE CO.
BIRMINGHAM 2, ALABAMA

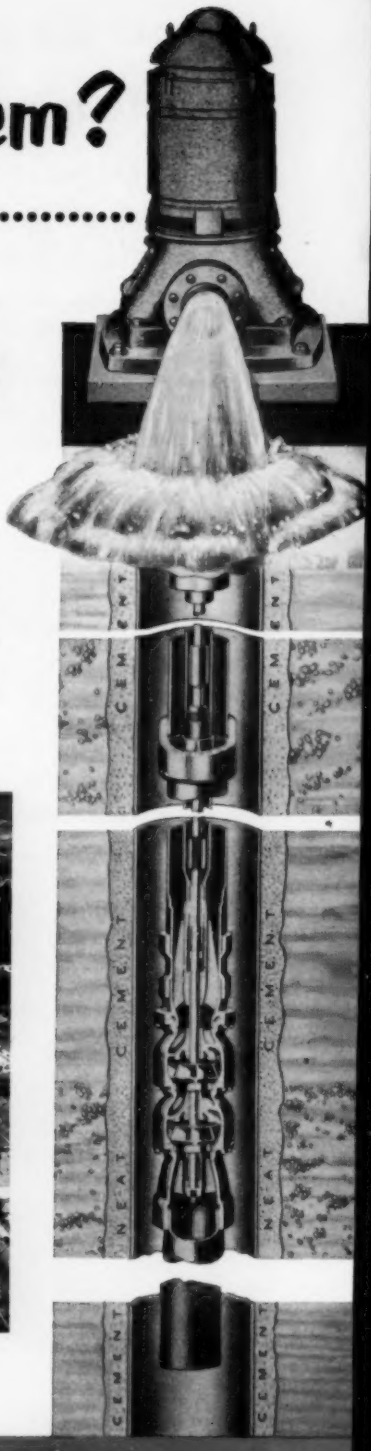
Water Supply a Problem?

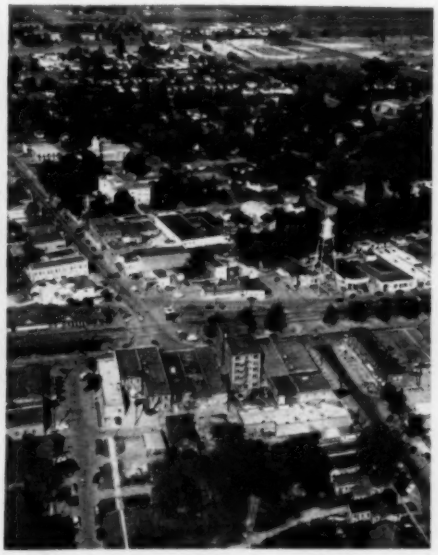
Large or Small.... You can Count on Layne!

To Layne Engineers there are no small jobs. Some are just larger than others. Whether your municipality needs 30 gallons per minute, or 30,000 gallons per minute, the delivery and quality of your water needs, when you need it, is what counts . . . and you can count on Layne!

Each installation requires the same research, the same calculations, the same truthful recommendations. Layne provides the same careful attention to every municipal water problem. Layne is concerned with just one thing . . . . the unfailing and economical delivery of water in the required quantities and desired quality . . . and you can count on Layne!

Write for our General Services Bulletin Number 100.





Cleveland, Ohio, or Cleveland, Mississippi—both cities require and receive the same attention regardless of their water needs. When you need water . . . . you can count on Layne!

1882 — 1957
Layne
75 YEARS OF PROGRESS

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

LAYNE & BOWLER, INC. MEMPHIS

General Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

you save money SEVEN WAYS with longer, stronger AMVIT Clay Pipe

Outstanding Mechanical Joint
on pipe 4 feet long or over
Available in 4" through 24" diameters

More than 200 major installations have been completed with outstanding results since Amvit Jointed Clay Pipe was introduced in 1955.

Such pioneer cities as Ann Arbor, Michigan, Dayton, Ohio, Camden, New Jersey have installed their second and third Amvit sanitary lines.

A mechanical joint designed for quick, low-cost installation, Amvit* will give you lower cost-in-place. Here's how:

1. QUICK INSTALLATION SAVES LABOR

No other materials such as caulking, joint compound, hot pots, or ladles are needed to make the Amvit joint. The joint is on the pipe delivered to the job ready for use. Just push the pipe together and the joint is complete.

2. IMMEDIATE BACKFILLING

You can backfill as soon as the line is completed. Barricades can be removed and streets opened days sooner.

3. QUICK TESTING

No need to wait days to see if a line has passed test. A look at the completed joint will tell. Thus, engineers can inspect and accept the line allowing the contractor to receive payment quicker.

4. CONTROLS INFILTRATION

Field tests from completed installations show that infiltration can be definitely controlled. Engineers can, thus, reduce infiltration specifications, use smaller diameter pipe and save in material cost.

5. ROOT PROOF

Amvit is a compression joint on the ball and socket principle. The surfaces of both bell and spigot are in uniform compression preventing root penetration.

6. BETTER FLOW, LESS MAINTENANCE

The design of the joint assures that the pipe is self-centered at all times. This gives perfect alignment and self-cleansing. Because the joint is really tight, no foreign matter such as dirt, sand and stones can possibly enter the line.

7. COMPLETE FITTINGS

Amvit is furnished on all standard fittings, as well as pipe. This will permit a uniformly tight line from house wall to treatment plant.

Amvit Jointed Clay Pipe, in sizes 4" through 24" together with all fittings is available for immediate delivery in the Northeast and Central States.

For more information on how Amvit can help cut your sewer project costs, write or call American Vitrified Products Company, National City Bank Building, Cleveland, Ohio, or our office nearest you.

*T. M. Registered, Patents Pending

SINCE 1900

AMERICAN

American Vitrified Products Company

CLEVELAND OHIO

MANUFACTURERS OF: Clay Pipe, Flue Liners, Clay Liner Plates and Concrete Pipe.

Plants Across the Nation . . . Brazil, Indiana · Chicago, Illinois · Cleveland, Ohio · Crawfordsville, Indiana · Detroit, Michigan · East Liverpool, Ohio Fenton, Michigan · Grand Ledge, Michigan · Lisbon, Ohio · Los Angeles, California · Milwaukee, Wisconsin · South Bend, Indiana · Uhrichsville, Ohio

LUDLOW

UP TO 72"

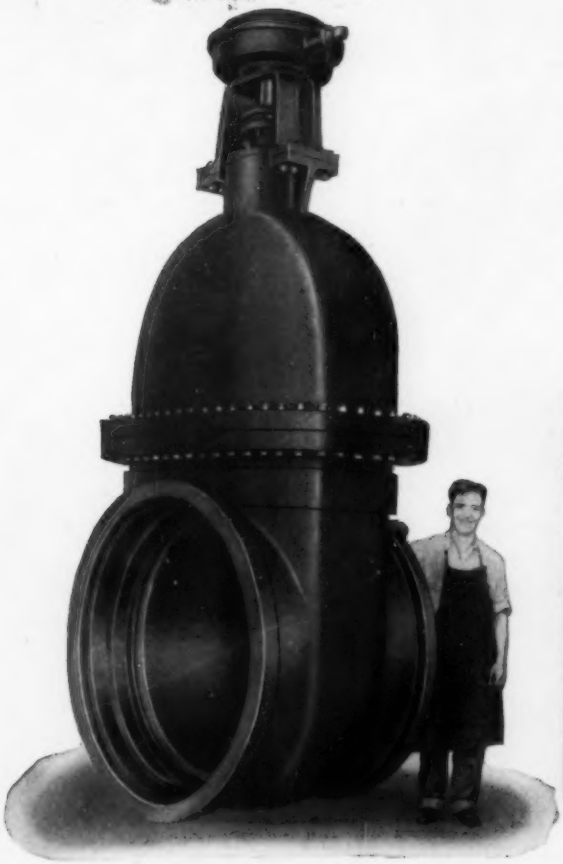
LUDLOW VALVES

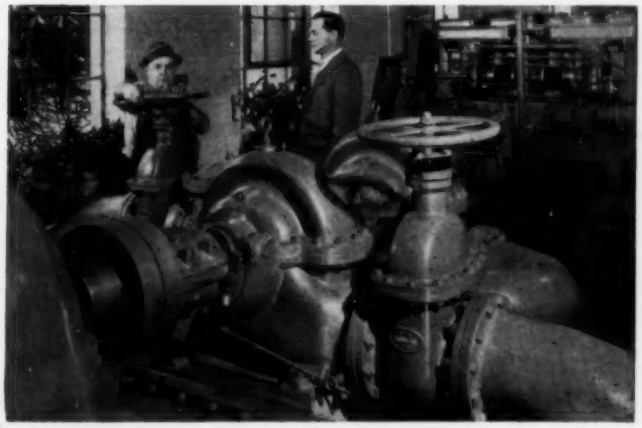
The water supply for thousands of people may depend upon a few large valves which must be reliable. Only a huge, specially equipped foundry, backed by giant tools, in a modern precision machine shop can supply this dependability. Ludlow has been the headquarters for large valves for nearly a Century.

LONG LIFE and DEPENDABILITY are built in. Ludlow Valves are fully bronze mounted. The two piece wedging mechanism is simple and rugged. The double disc parallel seat construction results in a wiping action that cleans the seat during the closing operation. The stems are special high tensile strength Ludlow manganese bronze with precision cut modified acme threads. A complete line of sizes from 2" to 72".

"NO POSSIBLE DIFFERENCE IN FIRST COST CAN OVERBALANCE THE PERPETUAL ECONOMY OF QUALITY."

17





Ask for Bulletin 54W

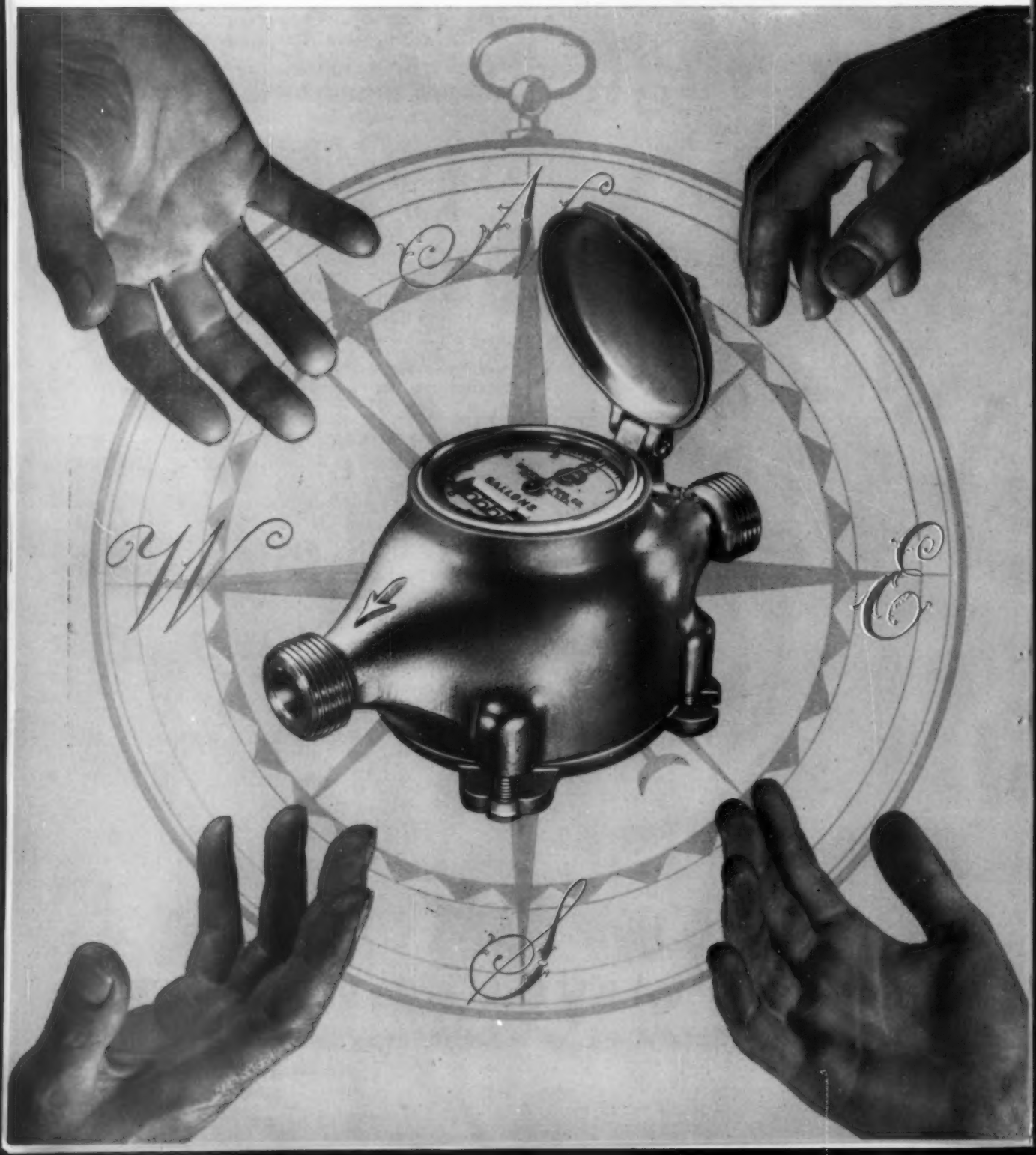
LUDLOW & Rensselaer

LUDLOW RENSSELAER **VALVES & HYDRANTS**

Since 1861 **THE LUDLOW VALVE MANUFACTURING CO.** *Troy, N. Y.*

IT SEEMS MOST

NEW ROCKWELL SEALED



EVERYONE WANTS REGISTER WATER METERS

From North, South, East and West . . . The Response Has Been Terrific!

When a few months ago, we introduced the Rockwell Sealed Register Water Meter, *we* knew we had something good. But your tremendous acceptance and response to this new idea in metering has exceeded our fondest hopes.

Surprisingly enough, this business has come from *all sections* of the country . . . from areas where fogged registers or corrosion are normally not problems . . . and from towns, cities and water companies all over the United States.

This is all very gratifying. It again proves that water works men *welcome change* when it means *betterment* . . . when a product such as the Rockwell Sealed Register Meter promises to make measurement more accurate, less troublesome and less costly.

Our thanks to all who have ordered these remarkable new meters. Production is being increased as rapidly as possible, but there will be unavoidable delays in filling everyone's needs. One thing is sure—production *will not* be rushed at the sacrifice of quality. Every meter shipped will be carefully made, inspected and tested. So please be patient. Rockwell Sealed Register Water Meters are well worth waiting for.

To the farsighted, we advise your anticipating next year's first quarter requirements for these new and better meters—now! *Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.*

PROMPT DELIVERY ON ARCTICS, TROPICS AND EMPIRES

In spite of the tremendous acceptance of the Rockwell Sealed Register Water Meter, we will continue to make and sell our standard lines of domestic meters. These meters are produced in separate facilities so prompt shipments can be made—usually from warehouse stocks.

"but not a drop to drink..."

Flood water is wild water . . . brutal . . . a killer!
Floods pollute your drinking water, spread disease. Erode the farmlands that supply your food. Destroy homes, cattle . . . disrupt communication, cost America over a billion yearly in damage.

Engineers are working hard to harness floods . . . and finding many answers. But flood control is only one phase of the complicated problem of keeping you amply supplied with water. They need your help in other ways. Cooperate.

1. **Encourage future water planning.**
2. **Support realistic water rates and water supply bond issues.**
3. **Conserve water where you can.**

With water, it's later than you think.

PROOF POSITIVE
CAST IRON PIPE SAVES
YOU TAX DOLLARS

This cast iron water main laid in Chicago in 1852 is still on the job. This is typical of many century old cast iron water and gas mains still serving throughout America.
Small wonder that where long life, dependability and economy are "musts", water officials prefer cast iron pipe . . . No. 1 Tax Saver!

CAST IRON PIPE
RESEARCH ASSOCIATION — SUITE 3440, PRUDENTIAL PLAZA, CHICAGO 1, ILL.

MODERNIZED cast iron

TOO MUCH WATER... OR TOO LITTLE

Floods, periodic heavy rains still lull many people into believing there's too much water.

Only greater understanding of the facts about water will convince them shortages do exist.

Advertisements like the one at left*. . . another in Cast Iron Pipe Research Association's continuing series on water . . . go a long way toward creating greater public sympathy and support for water programs.

Yours among them.

Cast Iron Pipe Research Association, Thos. F. Wolfe,
Managing Director, Suite 3440, Prudential Plaza, Chicago 1, Ill.

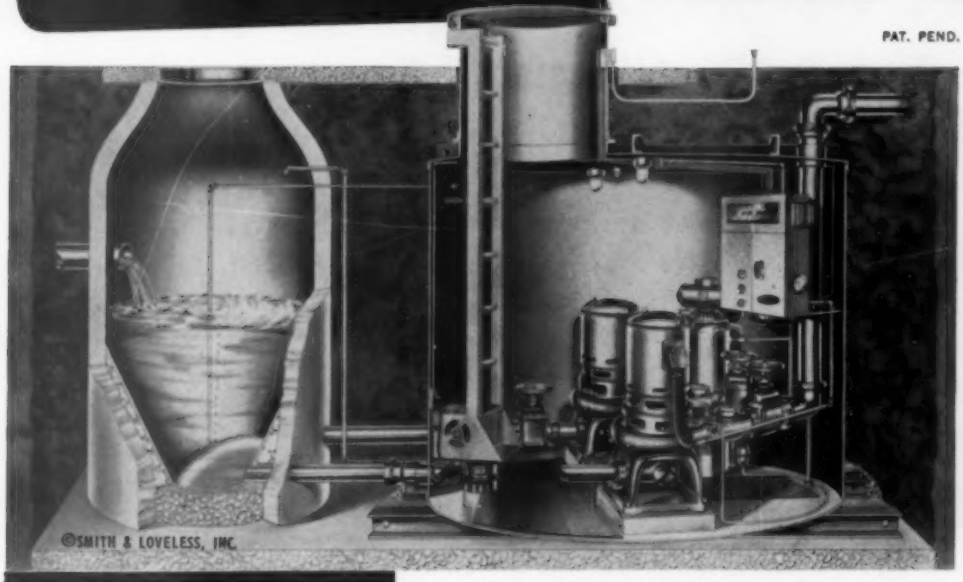
**Appearing in:* Saturday Evening Post, Newsweek, U. S. News and World Report, Nation's Business.

pipe FOR MODERN WATER WORKS

GRANITE CITY ILLINOIS NOW HAS... 7

Smith & Loveless FACTORY-BUILT SEWAGE PUMPING STATIONS

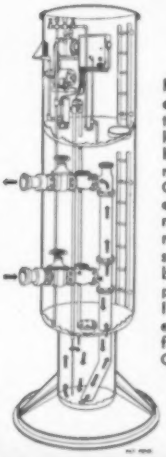
PAT. PEND.



TRIED TESTED PROVEN

HUNDREDS OF INSTALLATIONS IN OVER 30 STATES

FOR THOSE SMALL JOBS
Smith & Loveless
"MON-O-JECT"
FACTORY-BUILT
SINGLE PNEUMATIC SEWAGE EJECTOR STATION



Provides automatic equipment on installations of 200 G.P.M. or less for the modest budget. Requires a minimum of space. Completely automatic, extra large air storage, made of the very finest materials to meet the same high standards set by all Smith & Loveless products.
Installed underground, eliminates unsightly surface structures.
Cutaway drawing shows the operating cycle of the "MON-O-JECT".

Write for the S&L data manual.

Early in 1954, after comparison of advantages and costs by Sheppard, Morgan and Schwaab consulting engineers of Alton, Illinois, the City of Granite City purchased, through the General Contracting Company of Granite City, six Smith & Loveless Factory-built Sewage Pumping Stations. Subsequent city growth and expansion has necessitated additional facilities. Past experience with six Smith & Loveless pumping stations led to the installing of additional Smith & Loveless equipment.

Additional orders from original customers is truly proof of satisfaction.

Smith & Loveless makes a standard line of factory-built sewage stations to fit most normal installations.

CHECK THESE ADVANTAGES...

- Proven quality with factory-built savings
- Integrated design proven by the test of time
- Automatic dehumidifier to eliminate condensation
- Central control cabinet, prewired, color coded
- Precision assembled by factory experts
- Shot blasted steel structure, protected by "Versapox" coating and anodes
- Designed for minimum maintenance
- Factory tested and adjusted before shipment
- Delivered direct to job site

MAKERS OF WATER AND SEWAGE TREATMENT EQUIPMENT

S&L *Smith & Loveless, Inc.*

P. O. BOX 8884 KANSAS CITY 15 MO.

REPRESENTATIVES IN PRINCIPAL CITIES

For job recommendations, complete specifications and drawings, all part of the latest edition of the Smith & Loveless lift station data manual.

WRITE DEPT. 20

MUELLER®

AWWA Improved Fire Hydrant

add pumper nozzles to your present hydrants!

Pumper nozzles may be quickly added to your present two-way Mueller Improved Fire Hydrants at very little cost. Just order a new upper barrel, with the nozzle combination you need, and switch it with the old one.

Better still, in place of that two-way hydrant you were going to order for a new area, order a hydrant with pumper nozzle. Then simply switch upper barrels, putting the pumper nozzle on the already-installed lower barrel and installing the two-way from your present hydrant and the new lower barrel in the new subdivision.

All operations are completed in a short time and from ground level — no digging or water shut-off is required because of the safety flange construction.

Consult your Catalog W-96, your Mueller Representative or write direct for full details on the many other features of the Mueller Improved Fire Hydrant.

...designed for above-ground maintenance!

Manufacturers of a complete line of fire hydrants for municipal, industrial and private fire protection systems.

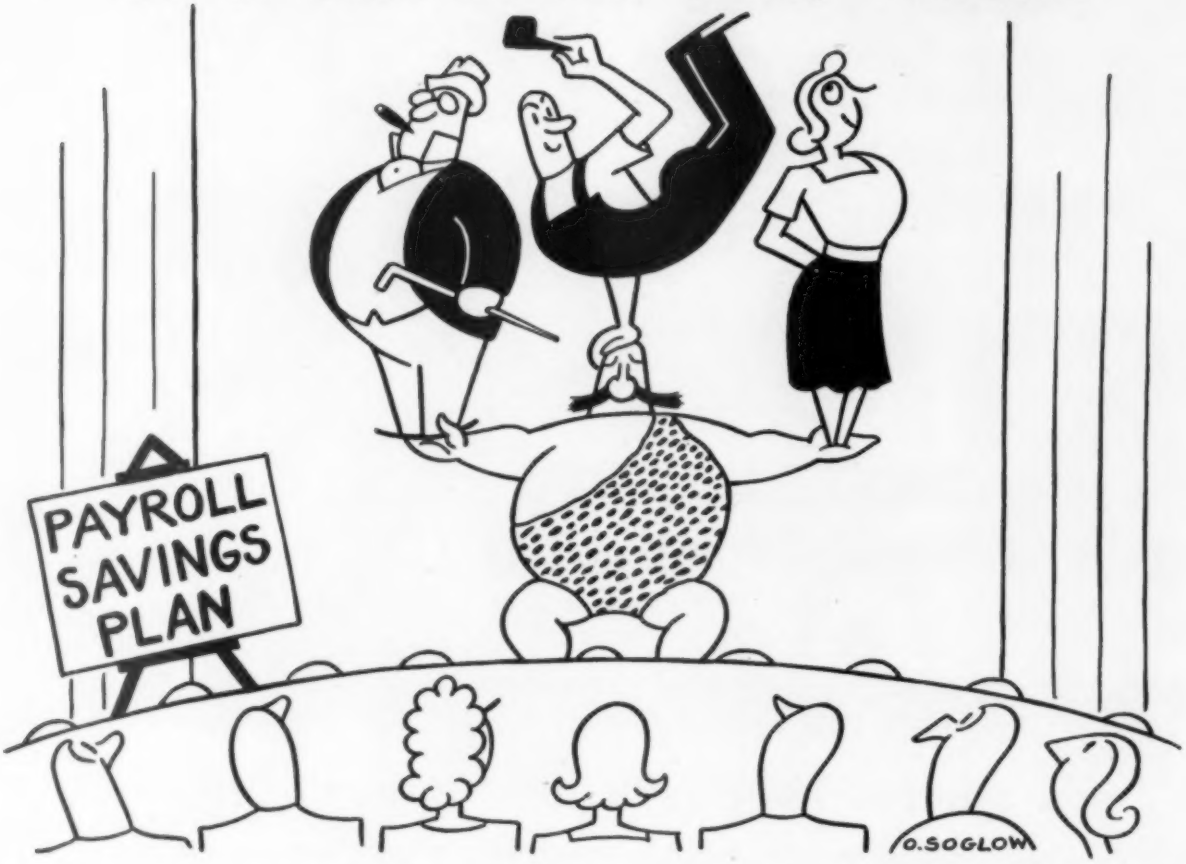
Since 1857

MUELLER CO. 100th YEAR SERVING the QUALITY

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles;
In Canada: Mueller, Limited, Sarnia, Ontario

"Got A Load On Your Mind? I Haven't"



Nothing gives employees a more luxurious, satisfied feeling than that of financial security. And nothing is easier for them to achieve when you provide the convenience of automatic Payroll Savings Plan.

EVERYBODY BENEFITS

Security breeds confidence—and confidence stimulates job interest and results in steadier people who are far more efficient in their work. Receiving those crisp Bonds at regular intervals along with their paycheck is an added inducement for employees to stay on the job.

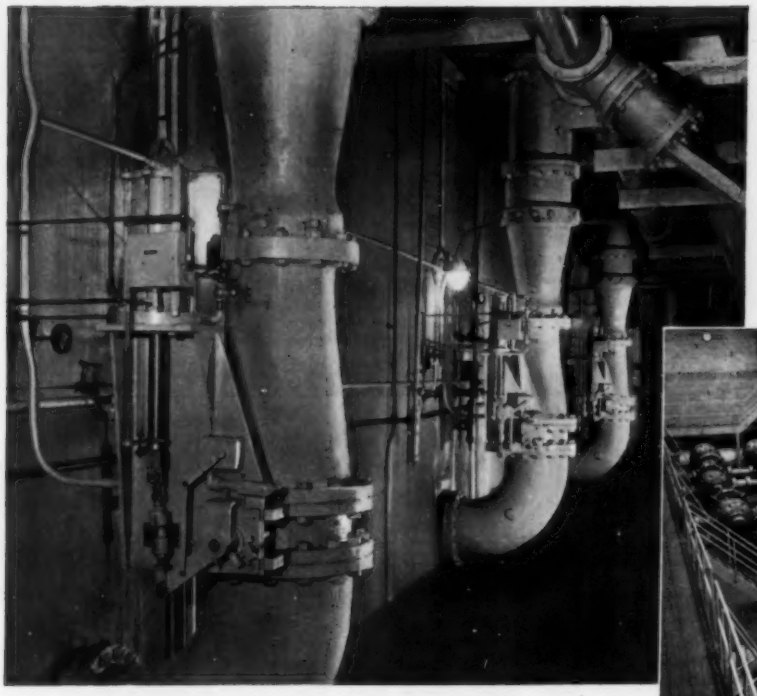
Moreover, when you install the Payroll Savings Plan in your company, you promote not only the security of your personnel but the security of your company and your country. Over forty million Americans have over 40 billion dollars invested in United States Savings Bonds—a backlog of purchasing power for the future.

EASY TO INSTALL

If your company does not now have a Payroll Savings Plan, or if employee participation is less than 50%, a letter to: Savings Bonds Division, U.S. Treasury Department, Washington, D. C. will bring prompt assistance from your State Director. He will provide application cards, promotional material, and as much personal help as you need.

The United States Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

WATER & SEWAGE WORKS



These 18″ R-S Butterfly Valves serve as both rate of flow controllers and shut-off on effluent to the filter. Automatic (pneumatic) positioners hold rate of flow set from filter floor. Compact R-S Butterfly Valves not only save space, but here **entirely eliminate conventional gate valves which would ordinarily be used for shut-off.**

Viewed from the Central Plant's gallery are two 18″ R-S Butterfly Valves used for pump check service on the low lift pumps in the foreground. A 24″ R-S Butterfly Valve for pump check and flow control is on the wash water pump (center), and three 16″ and 18″ Rotovalves for pump check on the high service pumps in the rear.

ST. LOUIS COUNTY WATER CO. CHOOSES R-S BUTTERFLY VALVES

At St. Louis County Water Company's Central Plant, 29 R-S Rubber-Seated Butterfly Valves, in sizes from 18″ to 36″, were installed for filter service in 1952. Chosen for their compactness and ease of operation, these valves have performed to complete satisfaction with only minimum maintenance to date. Tough rubber through the body and angular-seating vanes give positive closure, assure long service life.

Other R-S Rubber-Seated Butterfly Valves are also installed at the North and South County Filtration Plants. In addition, 24 Rotovalves are used in transmission mains and for pump check service, as well as 9 Angle Needle Relief Valves and 5 SMS-Ball Valves, which replace conventional gate valves in transmission mains.

These St. Louis installations are typical, for in the SMS line of Rotovalves, Butterfly and Ball Valves, you will find valves that meet your needs. For complete information, contact our local representative, or write S. Morgan Smith Company, York, Pennsylvania.

S. MORGAN SMITH HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

4

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

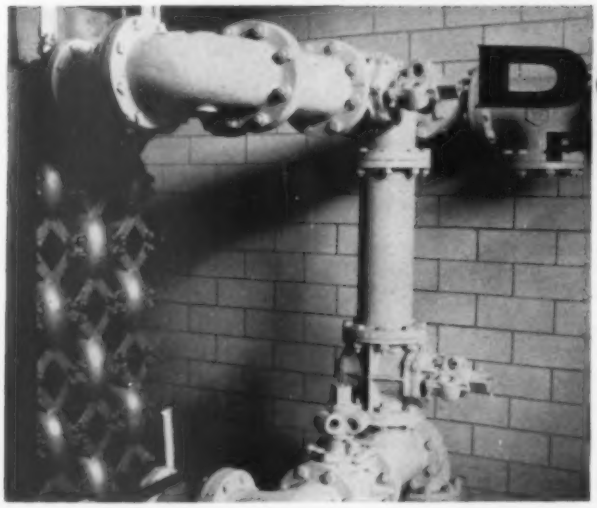
You get eccentric action

..you get resilient plugs

..you get tight shut-off

..you get easy operation

.....when you get



DeZurik
PLUG VALVES

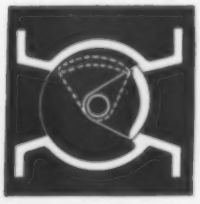
You get *all* these advantages exclusively on DeZurik Valves, because DeZurik—*and only DeZurik*—features the eccentric principal, providing easy operation and dead-tight shut-off WITHOUT LUBRICATION!

There are other advantages, too. For instance, with the valve closed, liquid is not "trapped" in the DeZurik plug to freeze or ferment.

DeZurik Valves are available in a wide range of models and in sizes from ½" thru 20"; a full line of remote operators is also available.

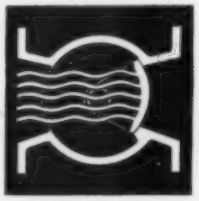
ECCENTRIC ACTION

Pivoting eccentrically, the DeZurik plug *backs away* from the seat and swings open freely—without friction! No jamming, no sticking, no binding!



EASY OPERATION

It's not necessary to use lubricants to get easy operation with DeZurik Valves. All friction between the plug and the valve body is eliminated by exclusive eccentric action!



TIGHT SHUT-OFF

Despite sand, metal chips, string, grit and other solids in the flow, resilient-faced plugs close tightly *around* any solids deposited on the seat. You get tight shut-off EVERY TIME!

Ask for details on DeZurik Plug Valves; representatives in all principal cities, or write

DeZURIK CORPORATION
SARTELL, MINNESOTA

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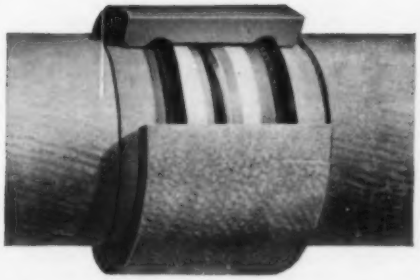
"K&M" ASBESTOS-CEMENT PIPE and exclusive FLUID-TITE Coupling



Exclusive sealing rings are the secret of the "K&M" FLUID-TITE Coupling installed with "K&M" Asbestos Pipe. All "K&M" couplings and pipe are hydrostatic pressure-tested to 3½ times the rated operating pressure!

No need to wait for dry skies or a dry trench before installing "K&M" Asbestos-Cement Pipe. Wherever water is to be piped under pressure, "K&M" Pipe is the modern answer. The exclusive FLUID-TITE® Coupling makes installation quick, easy—and permanent.

No special equipment; little skill needed. Just two easy steps: 1. Lubricate rubber rings; 2. Slide pipe into coupling. It is watertight immediately. The FLUID-TITE Coupling allows deflection up to 5° at each joint. Installation and maintenance costs go down when you specify the *modern* pipe and coupling . . . "K&M."

Meets specifications. "K&M" Pressure Pipe meets A.W.W.A., A.S.T.M., and U.S. Federal Specifications, and has Underwriters' Laboratories approval for all sizes (pipe and couplings) in Class 150.

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Selecting the correct device is simply a matter of choosing the one that best meets your requirements. The wide variety of Simplex Primary Elements makes this selection easy.

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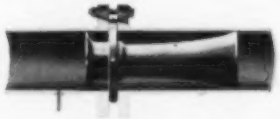
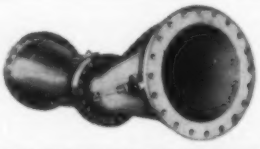
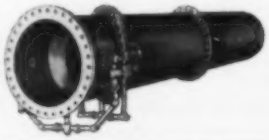
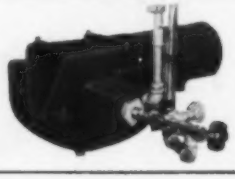
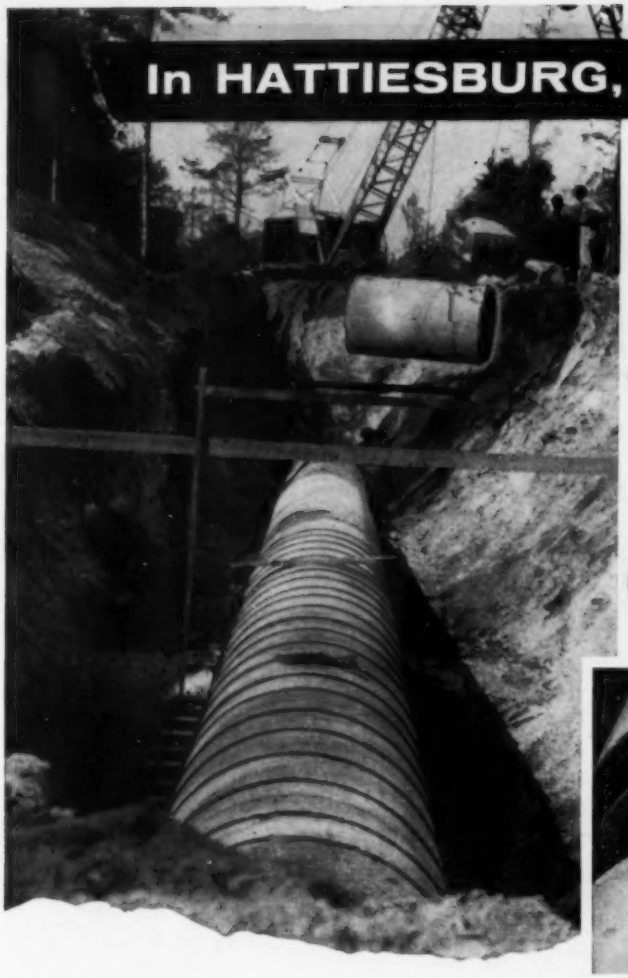
TRANSMITTERS • CONTROLLERS • TABLES • AIR VALVES

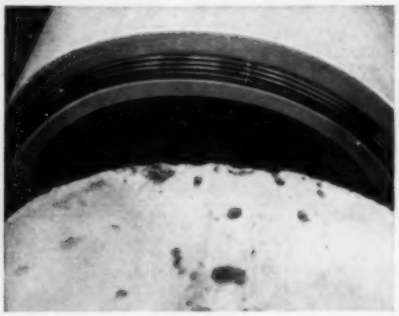
FLOW CONDITION		SOLUTION
NORMAL WATER, AIR OR GAS FLOWS		TYPE VT—STANDARD VENTURI TUBES Cast iron with bronze bushed main piezometer holes and bronze throat liner. Flanged, bell or spigot ends. Inspection opening at throat. Special metals for high pressures or caustic liquors, corrosive gases, brines, etc. BULLETIN 005
NORMAL WATER, AIR OR GAS FLOWS		TYPE TG—INSERT TUBES AND NOZZLES Withstand high pressures. Fit inside existing lines . . . permitting light construction. This, plus *short length*, cuts costs. BULLETIN 100
SMALL FLOWS OF WATER, GASES CORROSIVE FLUIDS		TYPE TF—MINIATURE VENTURI TUBES Machining to .0005" assures accuracy. Main diameters as low as ½"; throat diameters down to .1". Welded stainless steel models for high pressures. BROCHURE
NORMAL SEWAGE, SLUDGE, TRADE WASTES		TYPE VTJ—SINGLE TAP VENTURI TUBES Single taps at main and throat have bayonet-type valve for fast cleaning. Absence of pressure belts prevents clogging. Inspection opening at throat. BULLETIN 005
NORMAL SEWAGE, SLUDGE, TRADE WASTES		TYPE VS—FOUR TAP VENTURI TUBES Four cleaning valves at main and throat can be operated manually, by air, or hydraulically to keep piezometer holes clear for top accuracy. Two hand holes on each pressure belt and inspection opening at throat. BULLETIN 005
LOW-VELOCITY SEWAGE, HEAVY WASTES		TYPE VE—ELLIPTICAL VENTURI TUBES Developed specifically to accurately measure low-velocity sewage, sludge and heavy trade wastes—under low pressures. *Flat top* prevents air binding. *Flat bottom* is self-scouring. Inspection opening at throat. BROCHURE
LOW-HEAD SEWAGE, SLUDGE, TRADE WASTES		TYPE S—PARABOLIC FLUMES Full 20:1 range for open flows. Accuracy ±2%. Flanged, bell or spigot inlet for 6 to 36" lines. Integral sediment trap, piezometer reamer, gauge glass, direct-reading flow scale. BULLETIN 801

In HATTIESBURG, MISSISSIPPI *



They make pipe joints "LEAK-PROOF FOR LIFE" with

TYLOX RUBBER GASKETS



Swamp country . . . ! That was the location of part of Hattiesburg's new sewers. In deciding on the coupling material, engineers knew ordinary pipe joints would be no match for the conditions. The joints would be subject to severe STRESS from shifting sand, SOAKING from wet soil and CORROSION from rotting organic matter . . .

TYLOX RUBBER GASKETS were specified . . . the only jointing material engineers felt could successfully combat *all* the conditions. TYLOX, they knew, would offset slow trench work with fast pipe coupling, assure leak-proof joints with a rubber-tight *compression* seal, and, being made of non-deteriorating rubber, would outlast the pipe itself.

* **PROJECT:** City of Hattiesburg, Miss., sewer expansion.

ENGINEERS: Winchell Web & Associates, Consulting Engineers, Jackson, Miss., and Robert L. Morrison, Consulting Engineer, Hattiesburg, Miss.

CONTRACTOR: M & W Construction Co., Tupelo, Miss.

PIPE: 30" to 48" T & G Standard and Extra-Strength concrete culvert pipe with TYLOX Rubber Joints, furnished by Faulkner Concrete Pipe Company, Hattiesburg, Mississippi.

Send for

more TYLOX data and case histories. Hattiesburg is only typical of how big and little cities the world over use it to assure fast-working, leak-proof and long-lasting pipe joints. Always write "TYLOX" Rubber Joints when preparing specifications . . . There are no "or equals."

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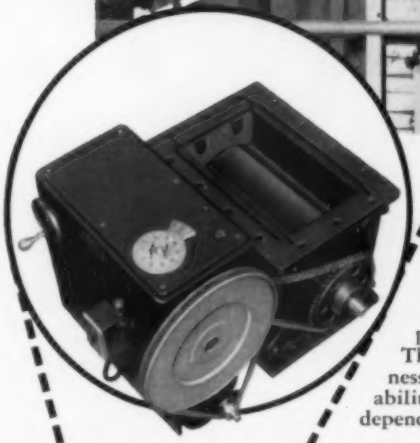

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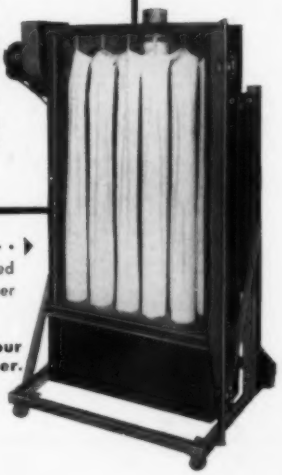
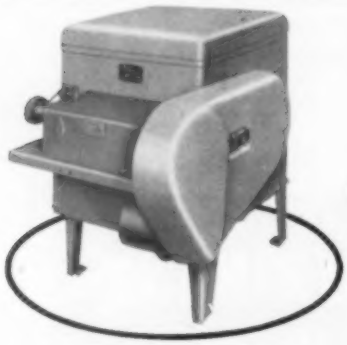
Features . . . completely enclosed housing; bag-dumping hopper; Rotolock for positive, non-flood feeding.





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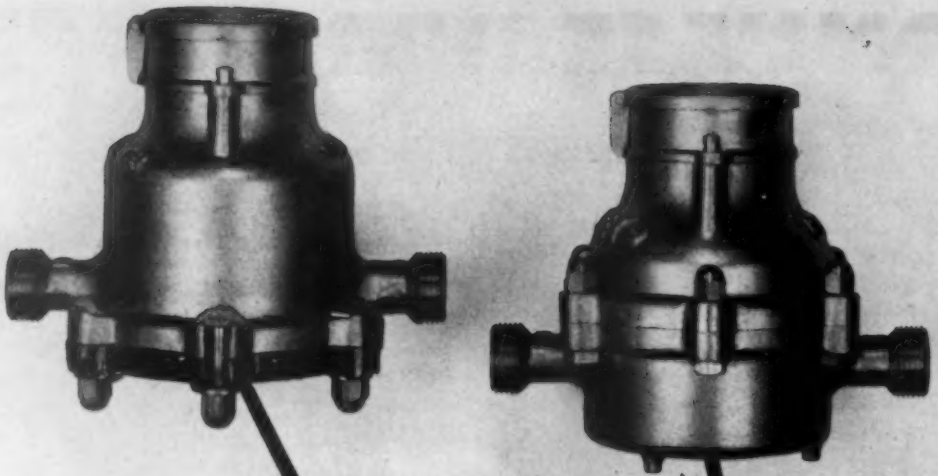

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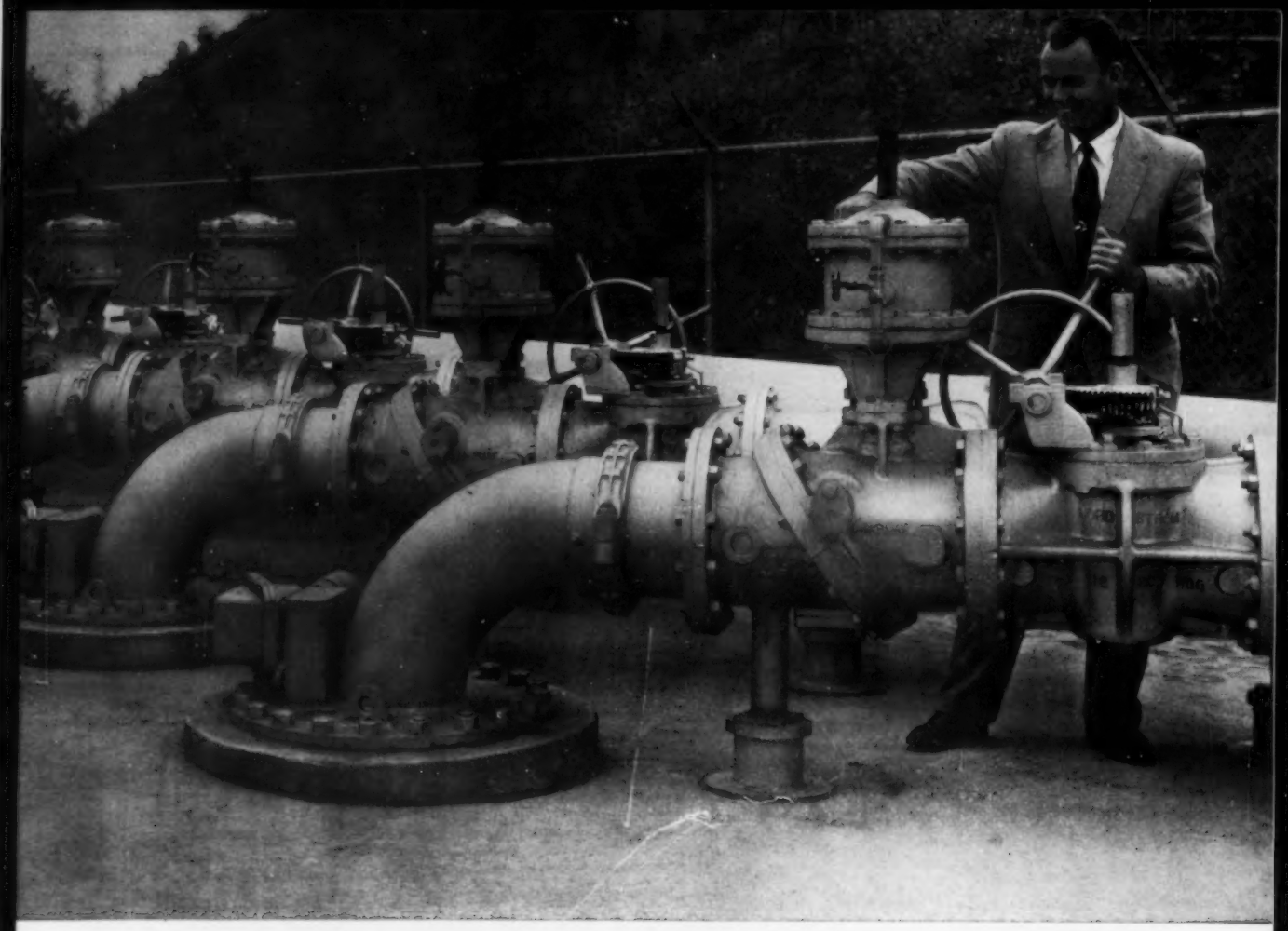

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Most water works valves are a lot of work in terms of operation and maintenance. Rockwell-Nordstrom lubricated plug valves save work (and money) because the combination of *lubricant* and a *tapered plug* means easy, trouble-free operation. Pressurized lubricant sealing assures positive shut-off with a smooth, easy quarter-turn. And the tapered plug and lubricant hydraulic jacking action mean *fast, easy* operation . . . stuck valves are eliminated.

Lubrication of any mechanism is preventive maintenance. For this reason Rockwell-Nordstrom valves cost far less to use and stay in service longer than any other valve.

Rockwell-Nordstrom valves—and a *complete* line of valve accessories—are available in sizes and pressure ratings for every water or sewage and waste plant service. They cost no more to buy, often less, than ordinary valves and they'll save you money everywhere you use them. Fill in the coupon for complete details. Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Valve Licensee:* Peacock Brothers Limited.

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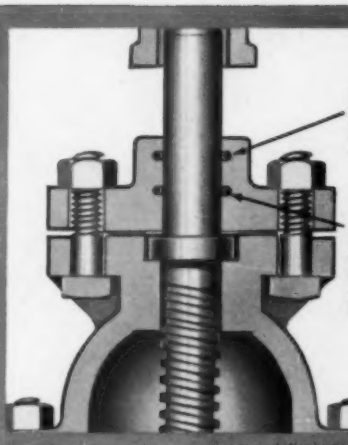
New CRANE A.W.W.A. Valves give you a wider selection

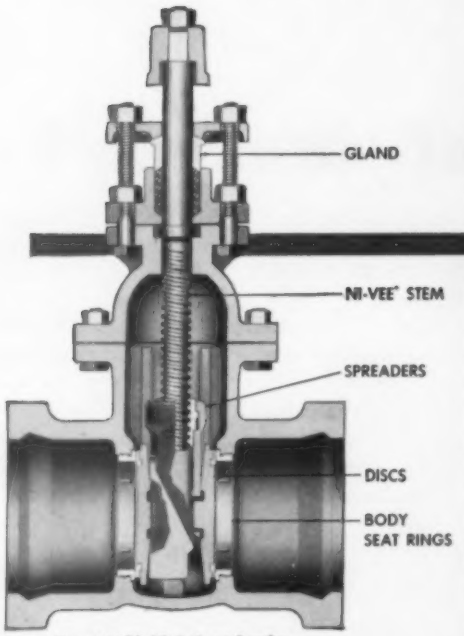
To meet special requirements, Crane now makes A.W.W.A. valves with two additional modifications. One is all-bronze internal parts. The other is a double "O" ring stuffing box as an alternate means of stem sealing.

The basic design of Crane A.W.W.A. valves—with free-to-rotate disc assembly—has never been surpassed for ease of operation, positive seating, and low maintenance. With or without the new modifications, Crane A.W.W.A. valves are the most economical for any municipality.



NOW—CRANE A.W.W.A. Valves with Double "O" Ring Stuffing Box

Prefer valves with "O" ring stuffing box to the conventional type? Order them from Crane. Two Buna-N "O" ring seals are used. Lower ring seals in the internal pressure; upper ring is an external dirt seal and reserve pressure seal. Crane A.W.W.A. non-rising stem valves with "O" ring stuffing box are available with hub, flanged or mechanical joint ends—in all sizes from 2″ to 12″.



No. 480-½-BD hub-end valve.

Crane's answer to your corrosive water problems—all-bronze internal parts

Where required because of unusual water conditions, Crane A.W.W.A. valves with *all-bronze internal parts*—body rings, discs, upper and lower spreader, gland and "Ni-Vee"* Type A stem—are available. With hub, flanged or mechanical joint ends—in all sizes from 2″ to 12″.

For complete information about Crane A.W.W.A. valves, ask your Crane Representative for Circular AD-2108, or write to address below.

*"Ni-Vee" is a registered trade-mark of the International Nickel Co.

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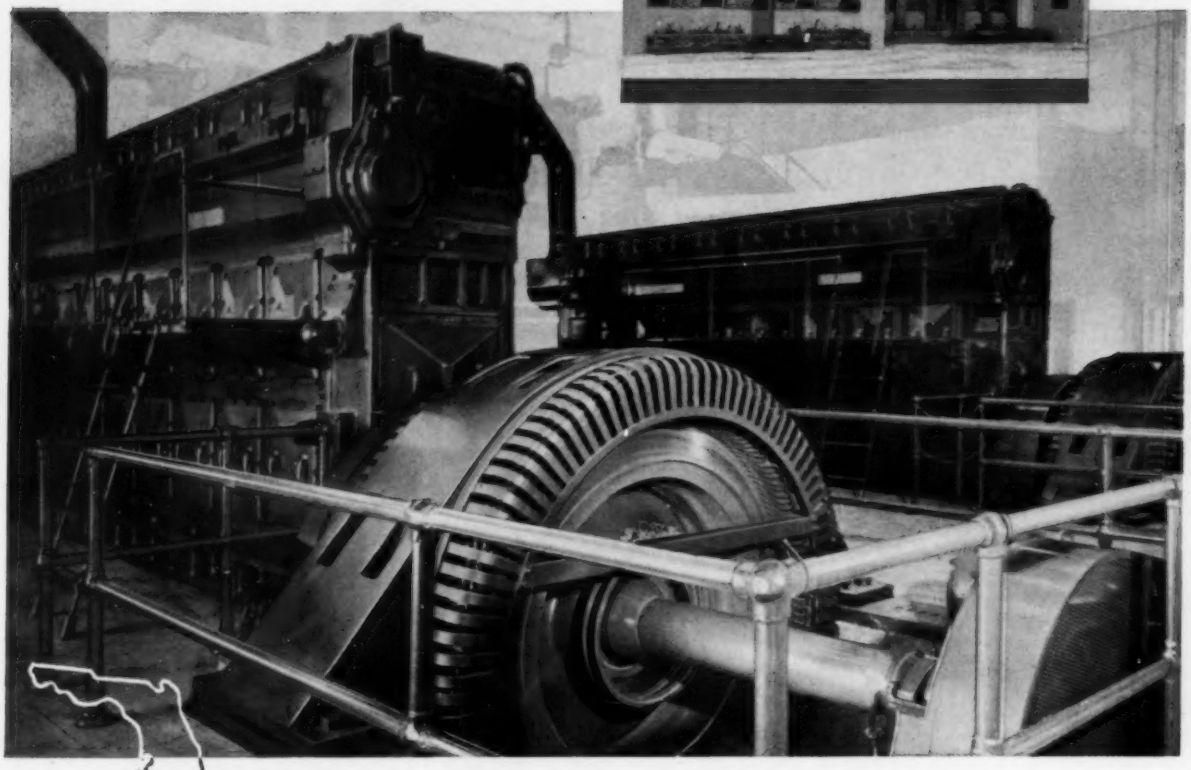

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True to the Florida town name of "Marathon," two dependable White Superior Model 80 Diesels are winning a real endurance contest at Florida Keys Electric Co-op Plant No. 2. Carrying base load in an area of tremendously increasing local demand, these rugged 8-cylinder 1422 HP supercharged diesels run almost 95% of the time on No. 6 residual fuel. For starting and stopping, No. 2 fuel is used. Saving is $25,518 yearly compared to cost of 100% operation on No. 2 fuel. Each 1000 KW unit is running almost continuously at rated output. In their first full year, they produced 10,638,410 gross KWH at a low fuel cost of 4.699 mills per KWH.

Economical operation on low cost heavy fuel results from Superior's highly developed open chamber combustion system plus special equipment and techniques perfected by White Diesel engineers. Rugged, heavy duty construction and high quality features enable Superiors to operate with minimum maintenance even where mushrooming local demand calls for peak output.

If extreme economy under "marathon" operating conditions interests you, call or write the nearest office listed below. Let White's engineers discuss the many outstanding features of Superior and Atlas engines, ranging from 100 to 2150 HP, for power to 1500 KW.

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But water meters, being fine instruments, naturally lose accuracy after years of wear. They start to give away revenue. They permit leaks and carelessness to creep back, and pumping costs go up. Eventually the water system cannot cope with the growing demand.

Worse yet, lack of proper income makes people hesitant to act, and water shortages may soon become critical.

How guard against this? Pick meters that stay accurate longer. Set up a good testing and repair program.

Walk into your meter repair shop. Talk to the men whose efforts guard your water supply. Ask them which meter gives highest sustained revenue . . . with lowest repair and depreciation costs. We sincerely believe the answer will be "Trident."

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WATER & SEWAGE WORKS

VOL. 104, NO. 8 • A Scranton Gillette Publication • AUGUST, 1957

METROPOLITAN Water District softening and filtration plant at La Verne, Calif., looking across filters and settling basins.

Softening of Municipal Water Supplies

With particular reference to its economic aspects

by WILLIAM W. AULTMAN

Mr. Aultman is Vice President of the James M. Montgomery firm of consulting engineers in Pasadena, Calif. In this article he discusses water softening, its economics, methods involved and current views on syndets as they affect the situation.

THE HARDNESS of a water supply is of special concern, not only to the individual domestic consumer, but more particularly to the commercial and industrial consumer. Hard water requires much soap to form a lather and more synthetic detergents to do proper cleaning. Hard water deposits sludges or incrustations on surfaces with which it comes in contact in vessels and boilers in which it is heated.

The householder judges a water to be hard if much soap is required in the bath to produce a lather, and soft if it lathers freely. The industrialist generally requires a specific quality of water for his process, and must condition the water to suit his needs if it is not already of satisfactory quality.

When is a water considered hard? The definition of a hard water is not precise. The recently published textbook by Fair and Geyer on "Water Supply and Waste-Water Disposal"[1] uses the definition generally accepted by water authorities. They say: "Waters containing less than 50 mg/l of hardness are considered soft; those containing more than 100 to 150 mg/l, the magnitude depending upon the regional composition of available water supplies, are considered hard." The designation mg/l means milligrams per liter, which is practically equivalent to parts per million (ppm), the term previously used to express the mineral concentration of solutions.

The substances responsible for hardness are calcium and magnesium ions and, to a lesser extent because of their normally smaller concentration, those of iron, manganese, strontium and aluminum.

Soap vs. Synthetic Detergent

With the advent of synthetic detergents the question that is asked is: "Why be concerned about softening hard water now that the synthetic detergents are replacing soap and the detergents work just as well in hard water as in soft?" The answer is that this statement is not correct. Also, the effect of water quality on the cleansing properties of soap or synthetic detergents is not the only consideration, for water quality affects many other factors that are of major importance.

The desirability of softening has been evaluated in the past primarily from the standpoint of obtaining a material saving in the cost of soap to the individual consumer. This factor has been used because it was one

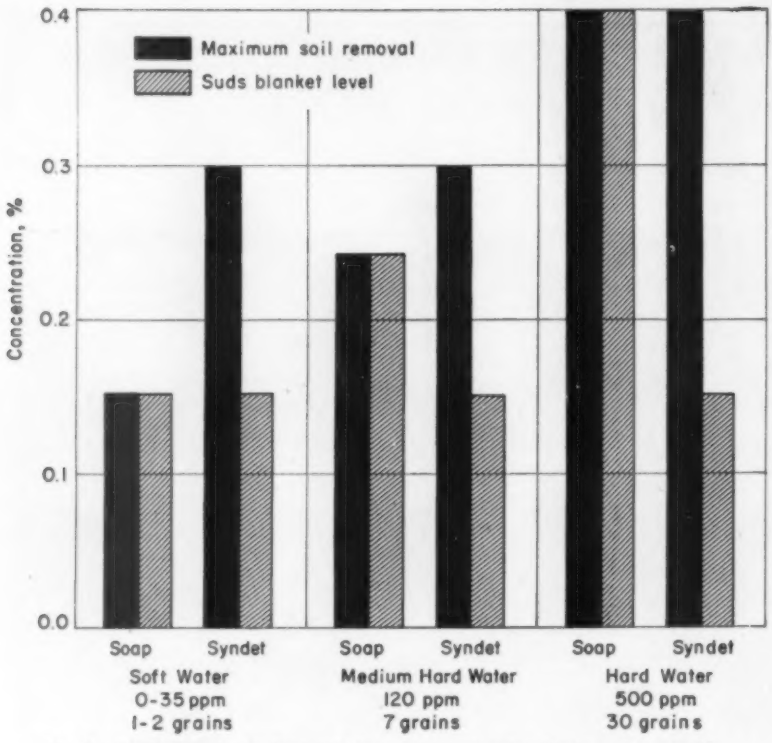


Fig. 1—DETERGENT requirements for suds vs cleaning (from reference 2).

thing to which a dollar value could most readily be assigned. However, this is but one of the many ways that hard water costs the consumer more than does soft water. This will be discussed later.

A definition of terms is desirable. Detergents are a cleansing aid, soap being one of the oldest and best known detergents. The newer types of "soapless" soaps are called synthetic detergents or syndets. Soap is a sodium or potassium salt of fatty acid made by combining an alkali with a fat. Syndets are complex chemical compounds made from petroleum or fats or oils. Builders may be added to soaps or syndets to give them greater cleaning power and/or some water softening properties. These builders are alkalies, such as carbonates, silicates, and phosphates [2].

Both soaps and syndets may be divided into two groups: (a) the mild, and (b) the "built" product. Mild soaps are the pure neutral soaps generally used for washing fine fabrics and for the bath. Built soaps are for heavier laundry purposes. Likewise, there are the mild syndets used for washing fine fabrics, such as blouses, hose, lingerie, etc., and the built syndets for heavier laundry of sheets, towels, shirts, etc. The syndets may further be of the high-sudsing or low-sudsing types.

TABLE I

Cost per Washing with Soap vs. Synthetic Detergent[1]

Water Hardness			Conc. for Max. Soil Removal,	Quan. per Box,	Retail Price per Box[2]	Washings per Box[3]	Price per Washing[4],
Type	grains per gal.	Product	%	oz	$		$
Soft	1 to 2	Soap	0.15 to 0.20	22	0.27	6 to 7	0.04 to 0.05
Medium		Syndet	0.25 to 0.30	18	0.27	3 to 4	0.08 to 0.10
Hard	7 to 10	Soap	0.25 to 0.30	22	0.27	4	0.06 to 0.07
		Syndet	0.30 to 0.35	18	0.27	2 to 3	0.10 to 0.11
Hard	20 to 30	Soap	0.40 to 0.50	22	0.27	2	0.10 to 0.13
		Syndet	0.40 to 0.50	18	0.27	2	0.13 to 0.14

[1]From "Soft Water, Detergents and Textiles," by Josephine Kingrose (2).
[2]Prices as of date of investigation (1951).
[3]Approx. number of washings per box, conventional machine.
[4]Approximate.

In using soap and water a blanket of suds indicates that sufficient soap is present to combine with the mineral hardness of the water, and also to provide cleaning power. With syndets, however, a blanket of suds may be produced before the amount of detergent added is sufficient to give maximum soil removal, or with certain types of syndets it is possible that little or no suds are formed at any dosage. Maximum soil removal refers to the level at which additional detergent does not increase the cleaning power appreciably.

The changing attitude of the syndet manufacturing chemists is shown by a statement in a recent article [3] which states:

"One virtue of synthetic detergents is that in general they give very soluble calcium and magnesium salts. It was expected that the detergency of synthetic detergents would not be adversely affected by hard water. However, the shift from soap to synthetic detergents did not entirely eliminate the hard water problem. Detergents provided only an apparent partial solution by not forming insoluble hard water salts. Later it was found that the addition of phosphate to synthetic detergents was necessary for acceptable detergency in hard water."

The phosphate is added as a water softener; the harder the water, the more phosphate required.

The relationship between the concentration of soap and syndets required to provide maximum soil removal has been determined by several independent investigators connected with firms that manufacture both soap and syndets, or who are employed as research consultants by such firms. The typical results found are shown graphically in Fig. 1 [2], from which it is evident that although the amount of syndets required to maintain the suds blanket level does not increase with an increase in hardness of the water, the amount of both soap and syndets required for maximum soil removal increases as the hardness of the water increases.

It is probable that the uniform appearance of suds when using syndets in different hardness waters has led to the apparent misconception that a given quantity of syndets is equally effective for soil removal in all waters regardless of hardness. In some cases it is possible that when enough syndets are added to obtain maximum soil removal the amount of suds produced may present a problem.

Another investigator [4] used zero hardness water and 400 mg/l hardness water while testing the efficiency

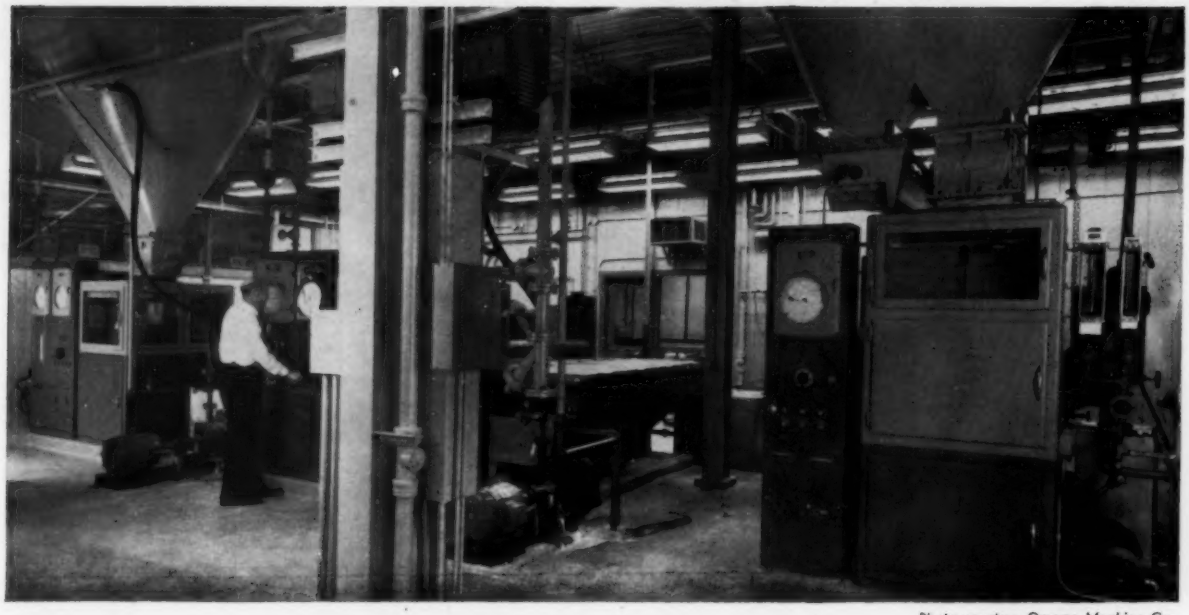


Photo courtesy Omega Machine Co.

SOFTENING by pebble lime is facilitated by the belt gravimetric feeders in the South County Plant of the St. Louis County Water Co.

of different makes of washing machines. Her report, which generally confirms the results shown in Fig. 1, states: "The concentration of high-sudsing built detergent in the wash water was 0.14 percent for soft water and 0.40 percent for hard water . . . These concentrations were selected after preliminary testing of several concentrations."

The preliminary testing was to determine the amount of syndets required for the different hardness waters to produce the same cleaning efficiency under controlled conditions. Under these conditions almost three times the amount of syndets were required for 400 mg/l hardness water than for zero hardness water.

Based on the relationship shown in Fig. 1, a comparison of the cost of soap and syndets when used with different hardness waters is summarized in Table 1 [2]. These data confirm the fact that the cost of soap for washing increases as the hardness of the water increases and also show clearly that the cost of syndets for washing likewise increases as the water hardness increases.

The application of these factors in evaluating the desirability of softening water is discussed later under the heading "Economic Aspects of Water Softening."

Development of various types of syndets for specific and general purpose continues. It is not known what the future may bring in the way of new and better syndets that will provide good cleaning properties for all materials and be less affected by the hardness of the water supply. With present technical knowledge, however, it appears that builders will continue to be required as additives to syndets to compensate for increased water hardness, and that the cost of cleaning when using hard water will continue to be greater than when using soft water.

More research is apparently necessary by the syndet manufacturing chemists to develop a product to which large numbers of people are not allergic, before syndets will replace soap for toilet use to any large extent.

Methods of Water Softening

To soften water, the hardness-forming calcium and magnesium must be removed or replaced by non-hardness-forming chemicals. The former is accomplished by the lime-soda ash process and the latter by the cation exchange process, which is commonly called the zeolite process. It is also possible to soften by a combination of lime-cation exchange, which removes part of the calcium and magnesium and replaces part with non-hardness-forming sodium.

Because calcium and magnesium are the major hardness constituents in normal waters, only these two elements are included in this discussion. However, when these constituents are removed during a softening reaction the other minor hardness-forming elements (such as manganese, iron, strontium and aluminum) are generally removed, also.

Reactions that take place when lime is added to a hard water containing both calcium and magnesium are:

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow MgCO_3 + CaCO_3 + 2H_2O$$

$$MgCO_3 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaCO_3$$

$$MgCl_2 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaCl_2$$

$$Mg(NO_3)_2 + Ca(OH)_2 \rightarrow Mg(OH)_2 + Ca(NO_3)_2$$

$$MgSO_4 + Ca(OH)_2 \rightarrow Mg(OH)_2 + CaSO_4$$

Reactions involving the use of soda ash are:

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$$

$$Ca(NO_3)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2\ NaNO_3$$

The calcium carbonate ($CaCO_3$) and the magnesium hydroxide ($Mg(OH)_2$) are relatively insoluble and settle out of the water when the hydraulic velocities are reduced sufficiently, as when the water passes through a settling basin or clarifier. This precipitate must be removed periodically from the settling basin and disposed of to waste. Sometimes the volume of sludge produced presents a serious disposal problem.

The cation exchangers—zeolites or resinous type exchangers—are of complex chemical composition, so for simplicity are generally represented

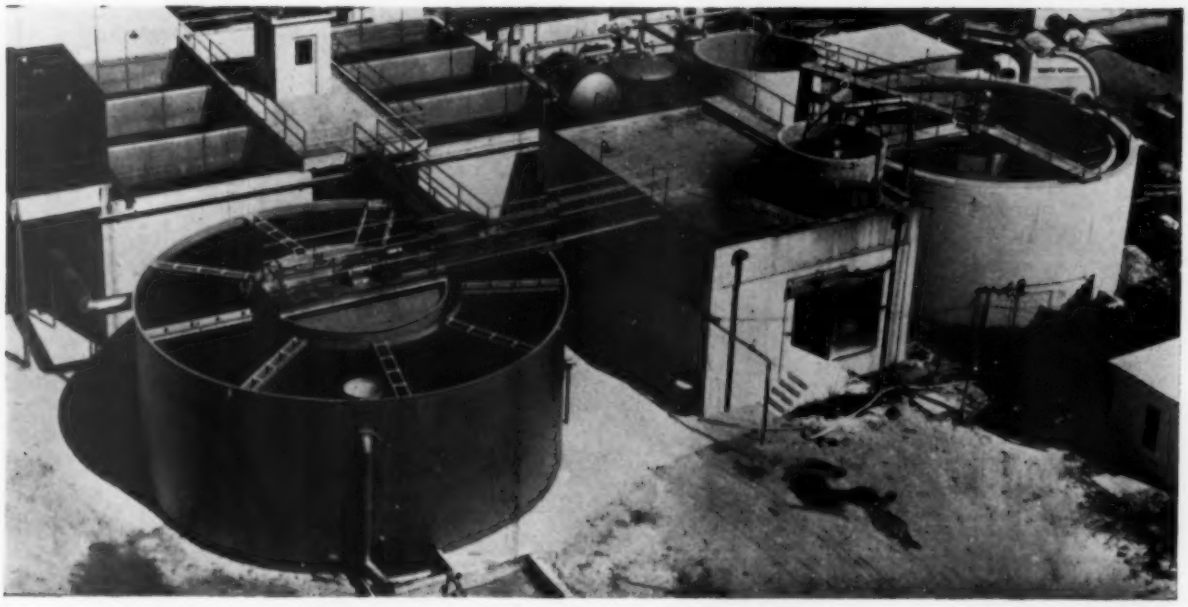


Photo courtesy of Infilco, Inc.

ACCELATOR® softening units at North Miami, Fla., include original concrete tank (right) with peripheral launder and later additional steel tank (left) with radial launders.

as Na_2Z or Na_2R, CaZ or CaR, MgZ or MgR, or H_2Z or H_2R, depending upon whether the exchanger is in the sodium, calcium, magnesium, or hydrogen form, respectively. Since most of the present cation exchangers are of the resinous type, the designation Na_2R and CaR is used in this discussion. In municipal softening the hydrogen exchangers are seldom used, although they may frequently be used in industrial water treatment.

The cation exchangers used in water softening resemble ordinary filter sand if they are one of the zeolites, or generally are of small bead shape if one of the resinous type exchangers. These compounds are remarkable in that they are capable of changing their composition by the exchange and re-exchange of their bases. In the regenerated, or sodium, form as Na_2R they are capable of removing the hardness-forming calcium and magnesium from water coming in contact or filtering through the exchanger. Upon exhaustion, this changes the composition of the exchanger to the calcium or magnesium form as CaR or MgR. The reaction is then reversible by the application of an excess amount of sodium chloride (NaCl), common table salt, to the exchanger.

The reactions that take place during the softening cycle are:

$$Ca(HCO_3)_2 + Na_2R \rightarrow 2NaHCO_3 + CaR$$
$$CaSO_4 + Na_2R \rightarrow Na_2SO_4 + CaR$$
$$CaCl_2 + Na_2R \rightarrow 2\ NaCl + CaR$$
$$Ca(NO_3)_2 + Na_2R \rightarrow 2NaNO_3 + CaR$$
$$Mg(HCO_3)_2 + Na_2R \rightarrow 2NaHCO_3 + MgR$$
$$MgCO_3 + Na_2R \rightarrow Na_2CO_3 + MgR$$
$$MgCl_2 + Na_2R \rightarrow 2NaCl + MgR$$
$$Mg(NO_3)_2 + Na_2R \rightarrow 2NaNO_3 + MgR$$
$$MgSO_4 + Na_2R \rightarrow Na_2SO_4 + MgR$$

The reactions that take place during the regeneration cycle are:

$$CaR + 3\ NaCl \rightarrow Na_2R + CaCl_2 + NaCl$$
$$MgR + 3NaCl \rightarrow Na_2R + MgCl_2 + NaCl$$

During the softening cycle there is no precipitate or no waste product formed. During the regeneration cycle the calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), and excess sodium chloride (NaCl) must be discharged to waste, together with the water required to rinse out these brines from the cation exchanger.

The combination of lime and cation exchange softening would normally be used where the water contains both calcium bicarbonate hardness and magnesium and noncarbonate hardness and where, because of the relative cost of lime soda ash and salt, it is cheaper to remove the bicarbonate hardness with lime and the magnesium and noncarbonate hardness with cation exchangers using salt for regeneration. When other costs are equal, lime softening is preferable, for by this process the total salines in the water are actually reduced, whereas by the cation exchange process they may be slightly increased.

Municipal vs. Home Water Softening

Studies reported by T. E. Larson of the Illinois State Water Survey [6] [7] have established the relative cost of softening water in municipal treatment plants and by home-owned and home-serviced softeners. His study also shows the corresponding relative cost of soap to accomplish the same degree of softening. It is pointed out that municipal treatment seldom softens the water below a total hardness of 85 mg/l, while both the home-owned and home-serviced units soften the water to a nominal hardness of zero.

The relative costs as developed by Larson are shown in Table 2. Based on the smallest cost reported, which is for salt for softening 85 mg/l hardness water in home-owned units, the relative costs of the other methods or degrees of hardness are shown as a ratio to this smallest cost.

Examination of Table 2 shows that municipal softening is the cheapest, even when further softening to practically zero hardness is done by household-type softeners.

The results of a survey by one of the soft water service companies on the distribution of installations of rental type units are reported by Larson and are shown in Table 3.

The data show clearly that municipally softened water benefits those with low and medium incomes more than those with high incomes. However, the soft water service companies, as well as their customers, benefit from municipal softening. Not only is the major portion of the hardness removed in the municipal plant,

Photo courtesy Walker Process Equip. Co.

LIME SOFTENING as well as algae and color removal are accomplished in these three Clariflow units at Orlando, Fla.

but also any iron, manganese, turbidity, color and odors generally are removed.

Increasing Demand for Softened Water

Examination of the records shows that the demand by the public for softened water has been increasing at a high rate since World War II, regardless of the fact that the sales of synthetic detergents have been increasing rapidly during this same period. If actual experience in the home had shown that hard water was just as satisfactory as soft because of the availability of syndets, people would not be spending the money to provide themselves with softened water by buying their own household softeners or by subscribing to a soft water service.

Home-owned softener units were first installed about 1910. By 1956 there were an estimated 1½ million home-owned units in the United States and Canada.

It was about 1936 when the first soft water service unit was installed in a home. With this type of service the company owns all the equipment and regenerates and maintains it, the customer paying for the service by a monthly charge. By 1950 there were approximately one million such service units in use in the United States, and by the start of 1956 there were approximately 1½ million units in use. One large soft water service distributor alone had over 40,000 units of this type in Los Angeles County in 1956 and the business has been increasing at the rate of about 400 per month.

The demand for softened water is another of the results of the general improved standard of living of the American people. It is also the result of people's actually experiencing the greater desirability of this type of water for household use, plus the nationwide publicity by softener and soft water service distributors calling attention to the specific benefits received. It has been shown repeatedly that once a person has become accustomed to soft water, either completely softened by the household-type unit, or only partially softened in a municipal treatment plant, he will not be satisfied to go back to using a hard water supply [8].

TABLE 2
Comparative Costs[a] of Softening Methods

Softening Method	Initial Hardness, mg/l			
	85	250	340	510
Municipal (to 85 mg/)[1]		2.0	2.7	4.0
Home-owned (salt cost)[2]	1.0	3.0	4.0	5.7
Home-serviced	10.0	17.5	23.0	34.0
Soap	2.6	5.8	7.6	10.8

[1]Shown as ratio to lowest cost per given unit of water volume.
[2]Not including amortization of softener.

TABLE 3
Distribution of Rental-Type Softening Units

Income Bracket	Annual Buying,	Proportion of Spending Units,	Proportion of Total Rental-Type Units Installed,	Proportion of Families in Bracket Receiving Soft Water Service,
	$	%	%	%
High	> 7,000	6	27	90
Middle	2-7,000	64	57	18
Low	< 2,000	30	16	11

Photo courtesy of Permutit Co.

AUTOMATIC hardness tester on each zeolite softener at East Aurora, N. Y. makes standard soap tests at required intervals and automatically starts multiport control valves for regenerative cycle when water tests hard.

Economic Aspects

Hard water is "hard" on the pocketbook. Special investigations were made by the Purdue University Experiment Station and the Michigan State Department of Health to determine what drawbacks there were, if any, to using hard water in the home which syndets cannot overcome [2]. Estimated national averages based on the results of these investigations indicate that:

1. A 25 percent saving is realized on fuel for heating soft water by eliminating deposits of scale which retard heat flow.

2. An 18 percent saving on repairing, cleaning and replacing plumbing that is caked with scale is realized.

3. Fabrics show 25 percent less wear and tear in soft water.

4. Soft water saves 16 percent wear and tear on utensils.

5. Food cooked in soft water retains its natural color and appearance, and its digestive qualities. In making tea and coffee it takes 50 percent less grounds in soft water than in hard water.

6. Soft water for skin care provides less possibility for skin dryness and irritation. Bathtubs do not develop the severe "bathtub ring" and expensive bubble bath preparations are unnecessary. Toilet bars, which are almost exclusively soaps, do not cause lime soap deposits on wash basins that must be removed by scouring powder and scrubbing. Shaving blades last 20 percent longer.

7. Washing machines do not develop suds lock or metal corrosion which syndets sometimes cause.

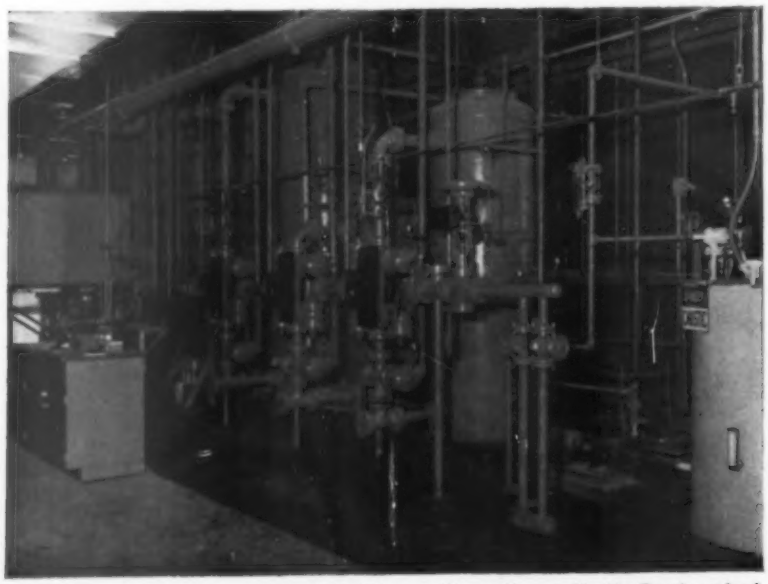
The foregoing percentages and favorable results will vary with the actual degree of hardness of "softness" of the water. The results reported in the foregoing listing are for water approaching zero hardness. This is the quality of water obtained from the individual household softener or from the rental-type home service units. Municipally softened water with a total hardness of 85 to 120 mg/l is still comparatively many times better than the 340 to 510 mg/l hardness natural water before treatment.

It is difficult, if not impossible, to attach a dollar value to many of the savings listed, but the saving is definitely there, and it is of appreciable magnitude. A dollar sign can still be placed on the saving of soap and/or detergents by the use of soft water in the home rather than hard water.

An average family of three will have at least three automatic washing machine loads of laundry a week, or a minimum of 156 a year. For purposes of comparison, let it be assumed that the natural water hardness is 20 to 30 grains per gallon (344 to 513 mg/l), which is softened in a municipal treatment plant to a total hardness of 5 to 7 gpg (85 to 120 mg/l).

Referring to Table 1, under these two conditions the approximate cost of soap per washing would be \$0.06 to 0.07 for 5- to 7-gpg hardness water; for the same water syndet would cost \$0.10 to \$0.11. For 20- to 30-gpg water the corresponding costs would be \$0.10 to \$0.13 and \$0.13 to \$0.16, respectively. Thus, the increased cost per washing due to the use of the harder water would be \$0.04 to \$0.06 for soap and \$0.03 to \$0.05 for syndet, and the increased cost for 156 washings (full year) would be \$5.24 to \$9.36 for soap and \$4.58 to \$7.80 for syndet.

Thus, it is seen that the increased cost of soap and/or detergents when using 20- to 30-gpg hardness water rather than 5- to 7-gpg hardness water might range from \$4.68 to



COMPLETE softening is accomplished by zeolite units at North Omaha plant of Omaha (Nebr.) Public Power District.

$9.36 per family per year *for laundry use only*. On the basis of the proportion of the different types of soap or detergent used, it is estimated that an amount equivalent to at least 50 percent of the foregoing costs would be attributable to toilet and kitchen use. Therefore, the increased cost for soap and/or detergents because of using the harder water would be at least $7.02 to $14.04 per family per year.

To this must be added the savings previously enumerated, to which it is difficult or impossible to place a dollar value. Considering the high cost of plumbing fixtures, hot water heaters, plumber's charges, and washable clothing, it appears quite probable that the savings should at least equal that shown for soap and/or detergents.

It could be expected, then, that a saving of at least $14.00 to $28.00 per family per year would accrue if 5- to 7-gpg hardness water were available for the family use rather than 20- to 30-gpg hardness water.

What would be the corresponding cost to this family of three if the water they use were softened in a municipal softening plant from a natural water hardness of 20 gpg (344 mg/l) to a hardness of 6 gpg (100 mg/l)? This cost is quite variable, depending on the type of hardness present (carbonate or non-carbonate), cost of chemicals, operating costs, and interest and amortization of the capital investment. All of these can vary greatly in different parts of the United States and depending on the type and size of the plant.

Costs Chargeable to Water Softening

The cost properly chargeable to softening would be materially different for (a) a surface water requiring coagulation and filtration in any event, with softening added as a refinement; and (b) a clear, iron-, manganese-, color-, and odor-free well water that normally would not be filtered except in conjunction with the softening process. In the former case, only the softening chemicals and small amount of additional plant operation and facilities required for softening should be charged to the cost of softening. In the latter case, all chemicals and all plant operation, including interest and amortization, should be charged to the cost of softening.

In the first case, the cost for softening would probably be less than $0.03 per 1,000 gallons. In the second case, the cost would probably range from about $0.06 to $0.10 per 1,000 gallons, depending on the type of treatment and the type and capacity of the softening plant. The cost of construction of a large treatment plant is less per million gallons of capacity than for the construction of a small-capacity plant. A cost of $0.06 to $0.07 per 1,000 gallons should be representative of all costs for softening in a plant of 30-mgd or greater capacity when reducing the total hardness of the water from about 340 mg/l to about 100 mg/l.

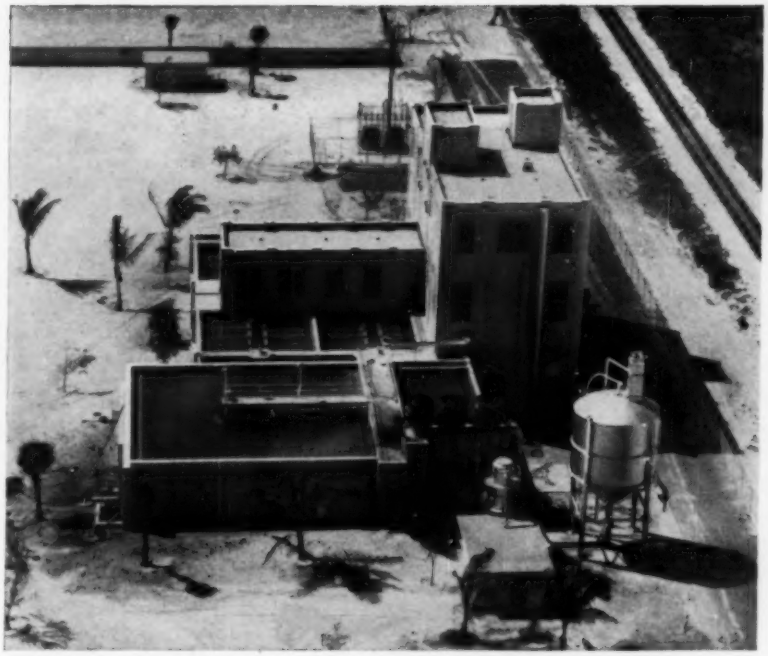


Photo courtesy Dorr-Oliver, Inc.

HYDRO-TREATOR® at Fiveash water plant serving Fort Lauderdale, Fla., is part of 8 mgd installation giving high-rate aeration, softening, filtration and chlorination.

An example of the actual annual cost of operation of a large softening and filtration plant will serve to substantiate these assumptions. The following costs are for the Metropolitan Water District of Southern California plant at La Verne, Calif.:

Design capacity: 200 mgd.
Type: Lime-zeolite softening and filtration.
Total cost of plant, exclusive of right-of-way: $7,662,980.
Method of financing: 50-year bonds at 4% interest.
1955-56 operations:
Total water softened: 55,681 mg, or an average of 152 mgd.
Average harness reduction: From a natural water hardness of 361 mg to a finished water of 141 mg, or a total reduction of 220 mg/l*.

Operating Costs:	Per Year	Per 1,000 gal.
Chemicals, power, and waste water	$ 794,284	1.426¢
Operation and maintenance	306,692	0.551
Employee retirement	14,632	0.026
Total operating cost	$1,115,608	2.003¢
Interest and amortization	356,712	0.641
Reserve for replacement	81,081	0.146
Total cost of softening	$1,553,401	2.790¢

* Normal softened water hardness is 125 mg/l. Higher annual average is result of operating plant in the summer as much as 67% above its designed capacity.

The salt for regeneration of the zeolite at this plant was purchased during this year of record at an unusually low price of $5.30 per ton delivered. If this cost of salt were doubled, which is about the normal price for such salt elsewhere, the foregoing unit costs would be increased $0.00878 per 1,000 gallons to a total unit cost of softening of $0.03668 per 1,000 gallons.

If the family of three, which has been discussed, uses an annual average of 140 gpd per capita, which is fairly representative of an average for the nation as a whole, they would use a total of 153,300 gallons per year. On the basis of the foregoing estimated costs of $0.03 to $0.07 per 1,000 gallons for softening in a municipal plant, the cost of softening the water used by this family would be from $4.60 to $10.73 per year.

Photo courtesy of Graver Water Conditioning Co.

REACTIVATOR® construction details and clarity of treated water are shown in this bird's eye view of a municipal installation.

It is evident from this that under the conditions of water hardness that have been used in the examples, and which are fairly representative of average conditions throughout the hard water areas of the country, the cost to the individual family for municipally softened water is less than one-half the cost to this family if the water is not softened. In addition, the family has the pleasure of this more desirable water, which cannot be evaluated in dollars and cents. Regardless of the advent and increasing use of the synthetic detergents, the necessity for and economy of water softening still exists.

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Jamaica Water's Little Green Scooters Roll Again

The Jamaica Water Supply Co. of Jamaica, L.I. has a summertime water distribution problem, necessitating lawn sprinkling restrictions. Sprinklers and hoses may be used only from 12 noon to 3 PM and from 9 to 11 PM by the company's 110,000 customers. However, every customer can sprinkle any or every day during these off-peak hours.

D. J. Hennessy, company president, explained that there is no water shortage, the restriction only being necessary to maintain good pressures and safe reserves for fire-fighting emergencies.

JWS consumers use about 42 million gallons of water a day during the winter months. Peak demand last summer, much of it for lawn sprinkling, was 90 million gallons a day, almost a 100% increase.

JWS has enlarged its plant substantially in recent years, mostly to meet these seasonal demands. About half of the company's 73 wells are used only during the summer months. Capacity has been increased 60% since 1953, at a cost of approximately $7,000,000. An additional $3,200,000. of new construction is underway for 1957 and 1958.

As in past years, JWS will have a crew of customer service representatives patrolling its area to call attention to the sprinkling regulations. They will ask consumers to turn off any sprinklers seen in operation during the "off" hours. These men ride little green scooters marked "JWS Customer Service" and, like all the water company's employees, are uniformed and carry proper identification.

WARNING!

In our May 1957 issue we published a nomograph for determining "FLOW in Rectangular Channels", or for determining channel design to accommodate anticipated flows.

We issue this warning to our readers that the nomograph has been found erroneous and should be destroyed. A corrected nomograph will be published as soon as the contributor, L. E. Livingston, Jr., of Dallas, Texas, supplies the corrected edition.

Phila. Section A.S.C.E. Has a Sanitary Eng. Div.

A Division of Hydraulics and Sanitary Engineering has been formed by the Philadelphia Section of the Am. Soc. of Civil Engineers.

At the organizational meeting a temporary Executive and Program Committee consisting of Walter A. Lyon, Chairman; Romeo Falciani, Vice-Chairman; and William T. Savage, Secretary, was elected.

The new Hydraulics & San. Eng. Division will meet on the 3rd Thursdays in the months of September, November, January, March and May at the Engineers Club, 1317 Spruce Street, Philadelphia, Pa. In addition to the regular meetings, field trips are planned.

So far some 84 engineers have indicated an interest in participating in the activities of the Division.

It is hoped that the Division will serve as a focus for professional interest for Hydraulic and Sanitary Engineers in the Delaware Valley area.

Third Installment

AWWA Annual Convention Report

On Purification, Management and Distribution Divisions

THE PREVIOUS ISSUE of *Water & Sewage Works* carried a report on the technical sessions of the Water Resources Division, the Water Works Practice Committee, and the General Sessions, as well as a report of the new officers of the Divisions and of the WSWMA. This installment will conclude the report and will cover the technical sessions of the Purification, management and Distribution Divisions.

A. P. Black

P. A. Coffman

J. E. Kerslake

N. E. Jackson

Chemical Feeding and Coagulation

O. Gullans

R. Ockershausen

Purification Division

The Purification Division held three sessions, one of which was devoted largely to committee reports.

Coagulation

"THE LABORATORY JAR TEST" as a means of arriving at the best and most economical dosage of coagulation chemicals, and coagulation aids in water treatment was discussed in a paper by A. P. Black, A. M. Buswell, F. A. Eidsness and A. L. Black —all of the University of Florida

Dr. Black, who presented the paper, reported that a survey made to determine the preferred equipment, materials and method of operating the laboratory jar test had revealed nothing really new. All use the same type of multiple stirring device, subject to variable speed control.

Historically, the first adoption of the multiple jar test, as we know it today, was that of Langelier, of the Univ. of California, made in connection with studies of the coagulation of Sacramento River water, and design of the treatment plant for Sacramento, Calif., in 1918 under the direction of Prof. Chas. Gilman Hyde. Based on these studies, the Sacramento plant was designed with flocculation tanks having a cylindrical (jar) shape and equipped with variable speed stirring paddles on a vertical center shaft.

It is believed that Baylis, at Baltimore, in 1920 was the next to utilize the laboratory jar test in coagulation control. Thereafter followed a variety of studies employing the mechanical mixing in jar tests. Geo. E. Wilcomb, in 1932, reported a preference for the churn-and-dasher type of mix and flocculation, the dashers being operated from a line of rocker arms on a horizonal shaft driven at variable speeds.

In summary, the authors find but little standardization in the laboratory jar test, and question the desirability of standardization until much more basic knowledge is had of the mechanism, of chemical coagulation, and floc formation. The pattern most widely followed is that of simulating plant conditions in the laboratory jar testing procedures. If standardization is to be effected, the following should be established—(1) Sample size; (2) Size and shape of containers; (3) Peripheral speed and duration of initial rapid mix; (4) The same for the slow mix period; (5) Selection of suitable criteria for determining the optimum chemical dosages.

Standardization may be desirable for research work or comparing results obtained on a variety of waters, but as of today, the laboratory jar test by all odds is (and has been) the water works man's most valuable tool in determining the overall best dosage of chemicals for a given water and given plant conditions.

This paper by Dr. Black and his associates comprises a splendid reference document on the history of modern water coagulation and flocculation up to the present, and a look into the future.

Coagulant Aids

"COAGULANT AIDS" were discussed by J. M. Cohen, of the Taft Sanitary Engineering Center, U. S. Public Health Service, Cincinnati, Ohio.

Mr. Cohen cited the use of synthetic polyelectrolytes, as coagulant aids, and reported on studies at the Taft Engineering Center where coagulation with 20 ppm of filter alum was inferior to 8 ppm when certain polyelectrolytes were used in dosages of 0.5 ppm only. On the other hand, a dosage of 2 ppm prevented floc formation. Concerning the toxicity question, Mr. Cohen stated that none of the synthetic polyeletrolytes has been completely cleared for use in public water supply and further studies of this feature were to be made through an AWWA Task Force. He stated that those produced from starch or cellulosic bases were not toxic.

A member reported that he had used 0.5 ppm of a synthetic polyelectrolyte together with activated silica to good advantage in up-flow clarifiers. However, this was an in-

dustrial supply. Audience objections were raised to toxicity and costs as retardants to use of polyelectrolytes. In reply, Mr. Cohen reported that as little as 0.05 ppm dosage often improved coagulation and floc formation with alum.

A representative of Diamond Alkali Co. stated that coagulant aids offered by his company had been proven non-toxic.

Radio-Active Culture Media

In a paper on a very rapid method of determining the coliform index of water samples through the use of radio active culture media, and special equipment, by G. V. Levin, V. R. Harrison, and W. C. Hess, was delivered by Mr. Levin, of Resources Research, Inc., Washington, D. C.

In this method radio-active lactose from the Atomic Energy Comm. is employed in the short incubation stage. The CO_2 produced is radio-active. It is drawn through a pad wet with Barium Hydroxide where the CO_2 is absorbed. The pad is removed, heat dried rapidly, and tested for radio-activity. Thereby, the results can be had in an hour's time from inoculation to completion. Details of the test and vest-pocket size cells are too much for reporting in this space. The method appears to be most sensitive to small numbers of coli.

Remote Chemical Feed Control

"Automation and Remote Control of Chemical Feeders" by Paul A. Coffman, Jr., Vice Pres. and Chief Engr., Omega Machine Co., Providence, R. I., proved to be an interesting talk from lantern slides showing the variety of applications of automation, and remote control of chemical feeders with great dependability and precision. He cited the few limitations on remote control with the pneumatic system, and variable speed motor system—also the automatic on and off control for intermittent pump-operation. For small plants, the all-electric system is preferred to the pneumatic system because of its greater precision. The importance of solenoid operated valves on the water supply lines to dry feeders was explained and stressed. Displacement type meters are satisfactory for reasonably steady water flow, but not so where the flow range is wide.

Mr. Coffman concluded with the statement that automatic chemical feed control is on the increase and becoming standard practice. The most recent addition is chlorine control by automatic registration, and recording of residual chlorine in the treated water.

Tastes and Odors from Organics

"Organic Components Causing Tastes and Odors in Water" by F. M. Middleton, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, was an illustrated description of the method of extracting taste and odor producing substances from water by filtration of a large volume of water through activated carbon. The carbon is dried, and alcohol used to extract oils, detergents, etc. The alcohol is distilled off leaving the foreign matter in concentrated form. It was his thought that almost any filtration plant could make the concentration test.

The following quantities of the several compounds could be detected by taste or odor in drinking water—

Material	Parts/Billion
Phenolics	250 to 4000
Chlor-phenols	1 to 100
Refinery Hydrocarbons	25 to 50
Petrochemical Wastes	15 to 100

Liquid Alum

With respect to the "Handling of Liquid Alum." J. E. Kerslake, Supt. of Filtration, Milwaukee, Wis., stated that in converting from dry to liquid alum a saving of $3.60 per ton was realized. A further saving of $2.08 per ton was also made by avoiding the handling costs necessitated by the use of dry alum. This total saving of $5.68 per ton will repay the total cost of the changeover within 2 years. Milwaukee still maintains the dry feeding equipment on a stand-by basis.

It was pointed out, however, that in order to effect these savings, the plant should not be more than 8 hours shipping time away from the liquid alum manufacturer's plant.

N. E. Jackson, of Camp, Dresser & McKee, Consulting Engineers, Boston, Mass., presented a series of slides showing various installations using liquid alum.

Oscar Gullans, Chief Water Chem. Engr., South District Filtration Plant, Chicago, Ill., reported on handling liquid alum at Chicago's South District Filtration Plant. The report included graphic sketches and photographs, and covered experiences with lead-lined concrete tanks for storage, stainless steel and plastic piping and valves, etc. Some of the difficulties encountered, and how they solved them were: dilution to prevent crystallization, increased velocity in feed lines to avoid valve clogging, coatings in pipe lines, foaming, filamentous growths in feeding equipment, and other problems.

D. Lurie, American Cyanamid Co., New York, N. Y., presented a brief discussion of American Cyanamid's development of liquid alum and enumerated several of the advantages offered by converting to the use of liquid alum.

R. W. Ockershausen, General Div., Allied Chemical & Dye Corp., Edgewood, N. J. showed slides locating the 40 different liquid alum plants in the United States. He then gave a general discussion emphasizing the facts that liquid alum can be purchased profitably only when the shipping distance does not exceed 100 miles. This is due to increased shipping costs for distances over 100 miles and included in these costs is the shipping of 1 pound of water for each pound of Al_2O_3. He also gave a brief discourse on the types of covered valves needed for handling liquid alum.

Leo Louis, Mgr., Gary-Hobart Water Corp., Gary, Ind., gave a brief discourse on the use of liquid alum by the Gary filtration plant.

Using slides to illustrate his report, Mr. Louis showed how the Gary-Hobart plant has liquid alum delivered by truck, how the alum is handled, after leaving the truck, and on through the plant to point of application.

Sludge Carbonation

F. A. Eidsness, Vice Pres., Black & Assoc., Inc., Gainesville, Fla., in his discussion on the Carbonation of Water-Softening Sludge stated that sludge volume increases according to the magnesium content. The magnesium content of the sludge is reduced to the soluble carbonate for calcining by saturating the sludge with CO_2. Mr. Eidsness also brought out that the saturation of sludge by CO_2 does not appreciably reduce the original carbonate content. He also gave a brief report on the laboratory and pilot plant tests held at the University of Fla., and the full scale plant operation at Dayton, Ohio.

F. G. Nelson, Dorr-Oliver, Inc., Stamford, Conn., reported on experiments in carbonation of water-softening sludge made at Dayton, Ohio and Lansing, Mich. He brought out that stirring during carbonation, a factor not mentioned by Eidsness, was desirable, being increasingly important as the percentage of solids in the slurry increased. In the production of high quality lime from recalcined softening sludge, it is necessary to remove inert material. This can be done successfully with the centrifugal cone or possibly with the proper size fine screen.

Fluoride Applications
(A Panel Discussion)

The discussion on "Experiences in Applying Fluorides" was mod-

erated by John R. Baylis, Engineer of Water Purification, Dept. Water & Sewers, Chicago, Ill. In his opening remark, Mr. Baylis discussed the use of fluorides at Chicago, the methods and equipment used and some of the precautionary testing methods.

J. C. Smith, Chief, Water Supply Div., Dept. of San. Eng., Washington, D. C., discussed the application methods, test methods, frequency of checks and check points used in the application of sodium silicofluoride to the Washington, D. C. water supply. He also stated that tests were made in various parts of the distribution system.

The health of employees handling fluorides was the subject discussed by J. W. Krasaukas, Chief, Plant Operations Branch, Water Supply Div., Dept. of San. Eng., Washington, D. C. Studies were made in cooperation with the U. S. Public Health Service.

The U. S. PHS tests used five subjects in different age groups. Complete medical histories were compiled on these individuals and records kept of annual check-ups. The check-ups included X-rays of the lumbar region, where fluorides show up first. The finding showed the individuals, under test, to be in normal health for their age group and there existed no factor indicative of fluoride exposure.

H. C. Medbery, Engr., Division & Water Production, Water Dept., San Francisco, Calif., in discussing the matter, stated that all fluoridation installations in San Francisco are fully automatic. Some trouble is being experienced in applying sodium silicofluoride due to the inconsistent size of the material from different manufacturers. The manufacturers cannot seem to adhere rigidly to the specifications in regard to granular sizes. In discussing costs, Mr. Medbery said that at the start of fluoridation, the cost was $1.45 per million gallons, but has since been reduced about 10 percent.

Fluoride feeding at Sheboygan, Wis., was discussed by J. C. Zufelt, Supt., Board of Water Commr., Sheboygan, Wis. Mr. Zufelt stated that in the feeding of sodium fluoride, some caking was experienced. In regard to employees' health, no adverse effect has been observed to date.

Concerning the accuracy of feed machines, Mr. Zufelt stated that in the 133 months of operation, the monthly average of daily feeds has only deviated more than 0.03 ppm during 3 of the 133 months. Also during the 133 months, 7,000 samples were tested and only 75 incidents of deviations of 0.1 ppm or more, plus or minus were found. Of the deviations, the maximum was 1.50 ppm; the minimum of 0.12, occurred when no fluoride was fed.

A. A. Bailey, Gen. Supt., Water Treatment, Montebello Plant, Baltimore, Md., discussed some of the problems experienced in feeding fluosilicic acid into the system, and stated that plunger pumps were abandoned when it was found that the oil needed in the pump packing and the fluorosilic acid caused the formation of a gummy substance that interfered with the pump operation. Also, Mr. Bailey said that hydrofluoride present in some of the fluosilicic acids supplied by different manufacturers, attacks the glass in the rotometers. Check tests indicate that no fluorides are stored in the distribution system, and there is no indication that employees are affected in any way.

E. L. Bean, Chief, Treatment Section, Water Dept., Philadelphia, Pa., in reporting on the feeding of "fluosilicic acid" in the system stated that the manufacturer sets the strength of the acid supplied, then it is the manufacturer's responsibility to maintain these specifications constant.

In relating an instance of employee contact with the fluosilicic acid, he told of how one employee received a splash of full strength acid directly into his eyes. The employee's eyes were washed out immediately with water, and he was then sent to the hospital where on the following day his eyes were washed out with water again. The employee has shown no deterioration in eyesight or ill effects of any nature as a result of the accident.

A. P. Black, Research Prof. of Chemistry, Univ. of Florida, Gainesville, Fla., reported that the results of tests and a recent questionnaire on fluorides indicated that the first thing that was needed to prevent loss of fluoride ions is to stabilize the distribution system. After the system is stabilized, fluoride ions are not lost in the system. Minute, nonmeasureable quantities of the ions are absorbed by tubercles, iron oxides, but even when subjected to a high flow rate, this will not measureably increase the concentration of fluoride in the flowing water.

B. C. Nesin, Director of Labs., Mt. Prospect Lab., Brooklyn, N. Y. stated that fluorides should definitely not be added to any water system due to the fact that the fluoride content in the water system could not be kept constant. He cited several tests in various localities that had been made to support this inconsistency. However, he refused to identify the localities or times when these tests were made.

J. R. Baylis

J. C. Smith

J. C. Zufelt

E. L. Bean

Fluoridation

H. C. Medbury

B. C. Nesin

Purification Division
(Committee Reports)

One session consisted of Purification Division Committee Progress Reports.*

Chromium and Cadmium

R. D. MacKenzie, Research Instructor, Kedzie Chemistry Lab, Michigan State University, East Lansing, Mich. presented a report on the STUDIES OF CHROMIUM AND CADMIUM SOLUBILITY AND TOXICITY. No toxicity to chromium has been evidenced by 25 part per million dosages on rats, however, some concentration in tissues has been noticed. Evidence has also been shown that cadmium also locates in animal body tissues. Cadmium evidences no pathological change in rats after one year's dosage at 10 part per million. There is indication that cad-

*Reported by V. W. Langworthy, Chief Applications Engineer, Omega Machine Co., Div. of B-I-F Industries, Inc. Providence, R. I.

mium accumulates in the kidneys and liver when quantities as low as 0.5 parts per million of cadmium are ingested. There are some indications that cadmium may influence certain enzyme systems.

Studies to date indicate that hexavalent chromium probably is more toxic than trivalent chromium when the two ions are fed at the same concentration, since chromium appears to be absorbed to a greater extent from ingestion of hexavalent chromium. Studies will be continued, using audio-radiographic techniques in the examination of tissue sections from animals exposed to cadmium and chromium.

Coagulation

Dr. A. P. Black, Research Professor of Chemistry, University of Florida, Gainesville, Fla., reported on RESEARCH ON WATER COAGULATION. This original two-year program, now extended to three years, has been going about one year, and Dr. Black reported that they are dealing with very dilute solutions and finely divided charged particles in suspension. Previous work on this subject is being re-examined by means of Cataphoresis cells in an attempt to determine the type, size and magnitude of particulate charges. The program also includes a follow-up and expansion on the means of action of polyelectrolytes in regard to color and turbidity removal as well as a study of silica sols in an effort to learn means by which their activity may be measured and compared.

Manganese

A. E. Griffin, Wallace & Tiernan, Inc., Belleville, N. J., reported on MANGANESE DEPOSITION IN PIPELINES. Manganese prevalence is general throughout the United States, and the Committee has completed a literature review which is being kept up-to-date. The water works profession should know the economic significance of manganese problems and what the minimum tolerance in water works should be. Basic research has been recommended to study the sources of manganese in public water supplies, comparison of current removal methods and other corrective measures. Reservoir studies should include water requirements with respect to manganese of special industries. Work should be done in an effort to improve on existing manganese testing procedures.

Liquid Chlorine Specifications

H. A. Faber, Research Co-ordinator, Office of Engineering Resources, Division of Sanitary Engineering Services, Department of Health, Education and Welfare, Washington 25, D. C., reported on SPECIFICATIONS FOR LIQUID CHLORINE. The Committee for the preparation of these specifications has been in existence three years and one conclusion reached is that analytical specs for liquid chlorine are difficult because of the nature of liquid chlorine and limitations of water treatment plants for carrying out testing procedures. Tentative specifications have been submitted (April, 1957). There is general disagreement among the chlorine producers as to method of choice for analyzing chlorine. The specifications as submitted are contained in five sections: (1) scope; (2) definition of liquid chlorine; (3) requirements; (4) impurities in liquid chlorine, further basic research is needed in this area; (5) methods of sampling, inspection and testing.

Purification Chemicals

J. E. Kerslake, Superintendent of Filtration, Water Purification Plant, Milwaukee 11, Wis., reported on SPECIFICATIONS AND TESTS FOR WATER PURIFICATION CHEMICALS. A total of twenty (20) specification and tests have been prepared, sixteen (16) have been published, the referee has reviewed three (3) and is now studying one (1). Mr. Kerslake reported that AWWA specifications should be used as a guide only by water works who should modify them, depending on local circumstances.

Fluorides

Oscar Gullans, Chief Water Chemical Engineer, South District Filtration Plant, Chicago, Illinois, reported on SPECIFICATIONS FOR FLUORIDES. There have been few problems with specifications for the three fluoride chemicals, sodium fluoride, sodium silicofluride and fluosilicic acid. There have been some discussions over coloring compounds to be used with blue dye as approved by the U. S. Food and Drug Administration finally selected. There has been revision of the section on impurities to consider all heavy metals which may be present, such as lead. Limitations have been placed on impurities as regards screen size due to caking and arching with too fine a product and feeding difficulties arising from a product too coarse. Fluosilicic acid has given some difficulty, particularly from specifications calling for specific gravity which has proved unreliable due to the presence of impurities. Each manufacturer should provide a specific table for his product.

Backflow Preventers

A. T. Dempster, Director, Bureau of Sanitary Engineering, Detroit Department of Health, Detroit, Mich, reported on BACKFLOW PREVENTERS. The work of this committee has been carried on jointly with the Conference of State Sanitary Engineers and the group has studied for four years devices based on the reduced pressure principle. There is a definite need for a permanent committee to study backflow preventers, because non-uniformity exists in registration and controls over use, testing and maintenance of these devices. The presently approved device is found to be acceptable in design and it has been subjected to flow and head loss tests. The group believes that head-loss can and should be reduced. All failures and reports on breakdowns should be investigated, however, no failures have been reported to date.

Standard Methods

M. J. Taras, Senior Sanitary Chemist, Springwells Filtration Plant, Detroit Department of Water Supply, Dearborn, Mich, reported on UNIFORMITY OF METHODS OF WATER EXAMINATION. A survey questionnaire covering water analysis was sent to 150 laboratories in the U.S.; eighty (80) were returned. The replies were helpful to the Committee now planning for the eleventh edition of Standard Methods. The eleventh edition will also revise some sections contained in the tenth edition in an attempt to eliminate gross imperfections. Two methods to be used in the determination for methane in water will be published in the near future. It was emphasized that volunteers in well-equipped laboratories are needed to assist in the testing and improving of existing methods. This program consists of distribution of unknowns to test existing and new methods being investigated.

Syndets

P. D. Haney, Black & Veatch, Consulting Engineers, Kansas City, Missouri, reported on EFFECTS OF SYNTHETIC DETERGENTS ON WATER SUPPLIES. The most used syndets today are sodium salts of sulfation of Dodecyl Benzine, commonly referred to as Alkyl Aryl Sulfonate, also called ABS. Their products may contain 20 to 30 percent ABS, some phosnator,

phate, sodium silicate and sodium sulfate. Some non-ionic detergents are coming into use, but an ionic type predominates. The Committee has evaluated a British report from the Metropolitan Water Board. This report includes studies of the persistence of surface active agents through the water treatment process.

Coagulants remove approximately 10 percent, activated carbon is good at high dosages (100 parts per million), chlorine normally has no effect on syndets, 0.8 parts per million syndet in water, causes foaming in laboratory tests and no short term health effects have been noted, however, there is a possibility that long term effects may be recorded.

Work at M. I. T. reveals that some syndets respond to biological attack, some do not, depending on the chemical structure. Frothing has given some difficulty in sewage treatment plants, rivers and streams and in some water treatment plants. Some interference with coagulation has been reported and assistance has been obtained from the association of soap and glycerine producers in studying the complicated problem.

Harry Kramer, Environmental Health Center, Cincinnati, Ohio, reported on ANALYTICAL METHODS FOR DETERGENTS, substituting for J. C. Vaughn. The report discussed two methods for determining syndets in water; Diggins (Chicago Modification) and the method of Longwell and Manisse. Analytical methods are more difficult and complex than the normal inorganic analytical methods used in water analysis. New tools and techniques are required. A fair degree of consistency was experienced from a distribution of Lake Michigan unknowns distributed during the past year.

Water Conditioning "Gadgets"

Rolf Eliassen, Professor of Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass., reported on WATER CONDITIONING AND PREVENTION OF CORROSION. The Committee has again evaluated the commercial "gadgets" being distributed for controlling water quality. The Committee recommends that the Purification Division make a report covering the fallacies of these devices. Studies performed at M. I. T. have not substantiated claims of distributors of the device that the "behavior" of the water is affected by devices of the Evis and Packard types. Studies showed that the hardness, PH or soap consumption ability of the water was unchanged as a result of exposure to this process.

Those in attendance at the session engaged in a spirited discussion over what the Purification Division should do with the information submitted by Dr. Eliassen. Two resolutions were passed, one, to publish Dr. Eliassen's paper, and the other to encourage AWWA to study ways and means of informing the public about the true facts surrounding devices of this type.

M. Rosen

A. P. Kuranz

L. R. Howson

B. S. Grant

Management Division

C. R. Erickson

F. Merryfield

Management Division
(Committee Reports)

The first one of two Water Works Management Division sessions consisted of committee progress reports.

Radio Communications

M. B. Cunningham, Dir. Public Works, Oklahoma City, Okla., in his report on RADIO AND MOBILE COMMUNICATION FACILITIES stated that an increase was expected in the use of radio for remote water level recorders and other types of reporting equipment. The question was raised about proposed changes in "Conelrad" procedures, and it was brought out that many suggestions have been made, but no definite changes are contemplated at present.

Fire Water

In reporting on WATER USE IN FIRE PREVENTION AND PROTECTION, A. A. Ulrich, Mgr. Massillon Dist., Ohio Water Service Co., Massillon, Ohio, presented a comparison of the new 1956 rating schedule with the old 1942 schedule. Some of the points covered in the new rating schedule are: More detailed requirements for plans and records; the qualifications of an assistant manager and assistant chief engineer were added; the emergency section is expanded to include radio; power valve operators and required where valves are larger than 16 in.; overload on filters should be increased from 25 to 50 percent; and other changes including valves on every hydrant branch.

In the matter of rating pipe, it was brought out that in Philadelphia, Pa., pipe has been found to tuberculate at the following rate: After 100 years a 6 inch main is considered a 4 inch main and charged for at the 4 inch rate.

Personnel Compensation

In regard to COMPENSATION OF WATER WORKS PERSONNEL, G. H. Dyer, Mgr., Missouri Water Co., Independence, Mo., stated that the committee had just been reactivated, and held its first meeting the day before.

In discussing the plans of the committee, Dyer stated that they will collect and analyze information on personnel compensation and establish proper levels for such ratings.

Pension and Retirement

J. G. Copley, Gen. Mgr., Elmira Water Board, Elmira, N. Y., reported that the committee on PENSION AND RETIREMENT PLANS had just been reactivated and had held their first meeting that morning.

The committee plans to bring up-to-date the old report that was published in the October 1950 issue of the Journal. One of the problems in assembling the information is that some states have passed enabling acts placing the personnel under social security and other states have not.

Job Classifications

In the report on JOB CLASSIFICATIONS, presented by R. S. Millar,

Mgr., Board of Water Commrs., Denver, Colo., it was stated that there are presently many job titles in many categories. In a number of cases, different job titles apply to the same job.

At the present time, almost all of the larger utilities have completed job classification studies. It was found that large utilities may have 100 or more classifications, whereas in small towns there is only one classification.

Water Use

H. E. Hudson, Jr., Hazen & Sawyer, Cons. Engrs., Detroit, Mich., in reporting on Water Use presented a short review of the 1954 Fortune magazine article on water use studies. He also reported that substantial increases in residential water use are in prospect due to the increased use of garbage grinders, dish washers, etc. Industrial use of water is expected to double within the next few years, but it is expected that the conservation practices used by industry will tend to limit the total amount of the increase.

The committee also plans to analyze water uses in North America by climatic provinces. To do this, the committee will need reports on peak demands from residential sections; industrial use to be eliminated. It was also stated that lawn sprinkling and air conditioning loads in residential area far exceed fire demands on the water system.

General Session

The Water Works Management Division general session consisted of three papers and a panel discussion.

Personnel Recruiting

The first paper, PROBLEMS IN PERSONNEL RECRUITING, was presented by M. Rosen, Commr. Public Utilities,, Dept. Public Utilities, St. Paul, Minn.

Mr. Rosen stated that the three main reasons for the lack of young personnel in the water works field are: (1) Inadequate compensation, (2) lack of job training and (3) antiquated ideas. He felt that the AWWA should become an extremely vocal group and crusade for higher wages for themselves and their employees.

The following recommendations were made by Mr. Rosen: (1) Stress the need for manufacturers to sponsor water department personnel problems, (2) Raise the salary structures, (3) Encourage young people, (4) Appreciate old employees publicly, and *most important,* (5) act now.

1957 Bond Market

G. I. McKelvey, Tucker, Anthony Co., New York, N. Y., in his paper on THE 1957 BOND MARKET stated that the water supply industry will need to borrow $500,000,000 a year for the next few years to meet the needs of a growing population. This will apply mainly to municipal plants. In the first 4 months of 1957, there was $200,600,000 in bond issues floated.

Mr. McKelvey urged the water utilities to borrow the necessary money, then raise water rates to cover the principal and interest charges. This obtains a better rating for the bonds and a better interest rate. The public must learn not to take the services of public water supply utilities for granted.

V. A. Appleyard

M. E. Flentje

Distribution Division
R. J. Sweitzer S. Logan Kerr

V. C. Lischer

F. G. Gordon

Wisconsin's Tax Policy

WISCONSIN'S POLICY IN MUNICIPAL UTILITY TAXATION, was the title of a paper presented by A. P. Kuranz,, Mgr., Water Utility, Waukesha, Wis.

The paper consisted of a discussion of the surveys, tests, meetings, actions taken, etc., necessary to formulate the laws that eventually were passed regarding municipality utility taxation in Wisconsin. The outcome was the establishment of a uniform tax formula for the turning over of funds to the city.

Water Utility Earnings

The panel discussion on WATER UTILITY EARNINGS was moderated by L. R. Howson, Alvord, Burdick & Howson, Cons. Engrs., Chicago, Ill.

C. R. Erickson, Mechanical Engr., Board of Water & Light, Lansing, Mich., in his discussion presented the results of a study made of 123 water supply systems that showed the total investment per dollar of revenue charged for the service, varying for different sized systems. The study showed that cities of 10,000 and under received $1.00 in annual revenue for each $15.00 invested. Larger cities showed a more favorable ratio, in some cases running down to $1.00 revenue for each $9.00 invested. Erickson also showed that the investment vs. sales ratio is much higher for the water supply industry than for other industries. He further stated that the water works superintendent should recommend the proper rate schedule.

The discussion by H. J. Grasser, Jr., City Water Works, Dallas, Texas, was presented in condensed form by K. E. Hoefle.

It was pointed out that since 1947 the city of Dallas has spent more money on water supply, than in the previous 65 years. Dallas will also require the expenditure of $80,000,000 for expansion during the next few years. In Dallas, all air conditioning units use the conserved water system.

B. S. Grant, Asst. Chief Manager & Chief Engr., Dept. Water & Power, Los Angeles, Calif., stated that if a utility is to provide adequate water service, it must not be subservient to any other function of municipal government. It must be operated in a proprietary capacity having control over its own funds; and it must collect from the municipality for all service provided, including public fire protection, at rates which as a minimum return all elements of cost. Currently, the average yearly per capita utility bills in Los Angeles are: Water—$12.00, Power—$35.00.

E. M. Hawkins, Jr., Mgr., Water, Gas & Elec. Dept., Danville, Va.,

stated that rates have not kept pace with rising costs. Over the last decade, water use in Danville has increased 10 percent and the water rates have increased 20 percent, but this does not offset the spiraling costs. Water works men must educate the public in the dollar value of a pure, palatable, absolutely safe water supply.

M. Whitaker, Gen. Mgr., Knoxville Utilities Board, Knoxville, Tenn., presented a paper on the FINANCIAL ASPECTS OF MUNICIPAL UTILITIES OPERATIONS. In describing the operations of the Knoxville water system, he stated that this system is treated no differently than the gas or electric systems. It is managed as a utility that has to pay its own way. The operating revenue dollar, operating expense, tax equivalent, amortization of bonded indebtedness, and earned surplus all come under scrutiny and are adjusted up or down in accordance with sound business principles.

The Knoxville Utilities Board of Commissioners is an autonomous body charged with the responsibility of serving the community and adjacent areas with gas, water and electric power. The Board's basic policy is expressed as follows: "To Provide adequate gas, electric, and water service to the utilities customers in an efficient and business-like manner." This policy is all-inclusive, and includes the expansion of the systems on a sound financial basis, there being no exception with reference to the water system.

B. E. Payne

J. H. Murdoch

T. E. Larson

R. F. McCauley

Distribution Division

L. S. Finch

E. W. Whitlock

Distribution Division

The Distribution Division held three sessions; two were devoted to technical articles and one to committee progress reports.

Automation

"APPLIED AUTOMATION" in water works was discussed by V. A. Appleyard, Philadelphia's Chief of Water Operations and by S. C. McLendon, of H. G. Holzmacher & Associates, consulting engineers of Hicksville, N. Y., in separate papers.

Mr. Appleyard told of the progress being made in the adoption of automation by the Philadelphia Water Department since its reorganization under progressive management. Telemetering is extensively used for a variety of purposes in which transducers receive the telemetering impulses. Microwave readings are transmitted to central stations. Automatic typewriters record field conditions to within 1 percent of accuracy, as revealed by field check readings. A load control center is manned by one employee per shift.

Mr. McLendon told of adoption of automation by the Long Island Water Co. Starting at the scattered wells, pump sequence is automatically controlled. Telemetered pressures at various points are recorded as is also the case with elevated tanks, as to elevation and direction of water flow during the 24 hour day. For checking pumping plant operation, the audio-tone reporting system is used. Conditions at 11 stations are telemetered to a central control station. The system was completed in 1956 with marked benefits.

Life Expectancy of Cement Linings

A report on studies of "SOLUTION EFFECTS OF WATER UPON CEMENT LININGS OF WATER MAINS AND CEMENT PIPE" was presented by Martin E. Flentje, Research Engr., Am. Water Works Service Co. and Robt. J. Sweitzer, Director of Research, Lock Joint Pipe Co.

Continuing the studies by the committee first reported to the Association two years ago, the conclusions then reached had been further confirmed. Observations on the 25 year old concrete pipe line of St. Petersburg, Fla., Hingham, Mass., Frenchtown, N. J., Milton, Pa., and Portland, Me., had revealed that the limit of extraction of calcium oxide could be placed at one quarter of an inch only with an estimated life for the cement lined pipes or concrete pipe at 100 years or longer.

Experimental work composing concrete with fine and coarse ground cement indicated no difference in the rate of solution of the two cements.

Water Hammer

S. Logan Kerr, Consulting Engineer of Flourtown, Pa., reported as chairman of the sub-committee, charged with the establishment of water hammer allowance in pipe lines in distribution systems. He said that water hammer allowances would be identical for cast iron mains of 20 inch diameter and smaller. Consumer practices creating water hammer need not be tolerated as long as the simplest corrective for water hammer is the control of rates of velocity change in the pipe line. The use of tomers to create water hammer could not be justified. Mr. Kerr pointed to the little known fact that water hammer may be noiseless, and may also create damage without actually breaking the pipe.

(Ed. Note: For his work on water hammer, and other hydraulic problems, Mr. Kerr was recognized at this convention by being made an Honorary Member of AWWA.

Vance C. Lischer, Consulting Engineer of St. Louis, Mo., reported on a study of air-chambers, so-called snubbers for the purpose of correcting water hammer in small lines. Mr. Lischer advocates the inspection of properties for water hammer by the water authority and require correction. After that a check should be made to see that the correction has been made.

F. G. Gordon, Ass't. Chief Engr., Chicago's Bureau of Engineering, reported that only one in sixty-four main breaks had been due to water hammer or surge. The smaller the pipe, the greater the number of main breaks per mile.

B. E. Payne, Chief Engr. & Supt., Louisville, Ky. Water Works, had very few cases of main break due to water hammer. His opinion is that

heavier pipe in order to permit cus-temperature changes are the most important and water hammer the least.

Responsibility for Main Breaks

John H. Murdoch, Jr., longtime counsellor in water utility matters, reported on how "THE COURTS CONSIDER PIPE LINE BREAKS". In brief, the water purveyor is rarely held liable for damages caused by a water main break unless negligence can be proved. This is very difficult to do. Mr. Murdoch did, however, issue a word of warning in connection with the water utility representative inspecting water piping arrangements on customer's property, and giving approvals. The water purveyor, thereby, might be held liable in case of subsequent damage caused by a failure of the approved arrangement.

Effects of Water Treatment on Water Mains

The initial report of the new committee studying "THE EFFECTS OF WATER PURIFICATION METHOD ON WATER MAINS", was presented by T. E. Larson, Head Chemistry Division, Illinois State Water Survey, Urbana, Ill., at the 1956 Convention in St. Louis, Mo. Mr. Larson, as committee chairman presented the second progress report at the 1957 Convention in the form of a paper by himself and R. V. Skold, Research Associate with the Ill. State Water Survey.

An evaluation of operating and field data from 11 water plants using Great Lakes waters, supplemented by laboratory studies reveals that the greatest single influence on corrosion of mains (resulting in tuberculation) is the concentration of calcium compounds and the saturation index of such. Free residual chlorine in Great Lakes waters proved corrosive to steel pipes but possible effects on cast-iron proved inconclusive. The effects of chloramines and silica are likewise difficult to appraise. The one certain element affecting corrosion was the calcium concentration in the presence of alkalinity and the relationship to the saturation index. However, for corrosion inhibition the calcium carbonate protective effect is observed somewhat before reaching the saturation concentration. The rate of carbonate film deposition is increased with increased velocity of flow, and likewise by raising the pH value to the point of calcium carbonate saturation or above.

Even in cases where the calcium alkalinity was below saturation considerable inhibitory effect was observed due to the observed rusty carbonate film under which no pits were found. Further study is required to formulate a definite relationship between high chlorine residuals, and corrosion, and subsequent tuberculation of cast-iron mains. Chloramine residuals do not appear to suppress tubercle formations.

Inhibitory compounds, other than calcium carbonate and bicarbonate, naturally present or added, are to be studied. To date, it appears that in carrying free residual chlorine, the importance of an effective calcium alkalinity is clearly evident, as a protective measure against corrosion and tuberculation increase.

(Ed. Note: A salute to John Baylis who pioneered Ca CO_3 protective film formation in water mains, through chemical adjustment of the treated water.)

"RIVER CROSSINGS OF OIL PIPE LINES" consisted of observations by Morrison Cunningham, Supt. of the Oklahoma City Water Dept., on the hazards of such crossings to water supply. His problem is that of 105 oil pipe lines crossings in 1/4 mile of river, the sizes being 4-6-8 and up to 22 inch lines. Anything can happen, and often does, in the form of oil leakage. A solution to this problem was not at hand.

In reporting on "SPECIFICATIONS FOR REINFORCED CONCRETE PIPE" the committee chairman, E. W. Whitlock of Malcolm Pirnie, Engrs., reported that specifications were being broadened to cover various cements used in the manufacture of reinforced concrete pipe.

Service Buildings

In his presentation of a general discussion of what it takes to provide the most useful "SERVICE BUILDINGS" for water works operation, L. S. Finch, Vice Pres. & Chief Engr. of the Indianapolis Water Co., (also V. P. of the Association) briefly described the new Service Building of the Indianapolis Water Co., as effectively described in the lead article of the May 1957 issue of *Water & Sewage Works* by Mr. Finch.

In desigining the $2,000,000 building, many conferences of Division heads were held in order to please one and all. He emphasized the facilities provided for the convenience of 200 employees employed in the building. These included a lunch room and kitchen; drying room for wet clothing; an ample locker and shower room with forced ventilated lockers. A matter of considerable importance is the separate entrance and anteroom for plumbers seeking permits, recommendations, etc.

Mr. Finch then reviewed what other water companies and cities are doing along a similar line. Colored lantern slides of a number of Service Buildings, and Maintenance equipment were shown. New buildings included those of San Antonio and Dallas, Texas; St. Louis County Water Co. and Kansas City, Mo., the latter to have a 100 car parking area on the roof. Novel equipment was the rotary parts bins for the Dallas plant and mobile meter rock of the St. Louis County Water Co.

(Ed. Note: Anyone interested in the design of a Service Building would do well to read the "Dos and Don'ts" in Mr. Finch's article in the May 1957 issue of *Water & Sewage Works.*)

Service Trucks

"SERVICE TRUCKS" in variety were pictured by colored slides and described by Fred G. Jones, Asst. Supt. of the Spokane, Wash. Water Dept., presently Secy-Treas. of the Pacific N. W. Section.

After showing and explaining the several types of service trucks at Spokane, and elsewhere, Mr. Jones emphasized, as did Mr. Finch, the importance in these times of holding employees by making their work pleasant and free of hazards. In this direction, a check-up on the eyesight of employees and correction of defects had materially reduced accidents and increased work output.

Meter Settings

A panel on "METER SETTINGS" was held under moderation of W. Victor Weir, Pres. & Genl. Mgr. of the St. Louis County Water Co.

G. E. Arnold's contribution was presented by Samuel Baxter, Philadelphia's Director of Water. In making 150,000 meter installations within a year under the new compulsory metering program of Philadelphia, Mr. Arnold strongly advocated the

use of meter yokes and meter horns. The former having only friction couplings were easily inserted in the existing water line in the customer's basement by merely sawing out a section of the line. Meter horns permitted a horizontal setting of 5/8-in. meters in a vertical line—quick, easy and economical. Horizontal setting was considered very important.

Mr. Arnold advocates and uses compound meters in preference to batteries of smaller meters. A compound meter of 6 in. size with 3/4 in. by-pass requires less space than a 6 meter battery of 2 in. meters. The compound meter requires less repairing and less expense.

Marsden C. Smith, Chief Water Engr., Richmond, Va., told of painting meter hands with iridescent paint for easier readings in meter boxes or vaults. Outside settings in curb boxes have only a 5 inch lid for ease of opening and safety to the public. Richmond uses both compound meters and battery settings—each to its own advantages. He showed slides of the latest engineered design for three different types of meter vaults which have decided advantages and will be well worth study when Mr. Smith's paper appears in the AWWA Journal.

(Ed. Note: Either Richmond has the ideal in its improved meter vaults or Marsden Smith is a top-flight sales artist.)

Outside vs Inside Meter Settings

James G. Carns, Meter Engr., Am. Water Works Service Co., Philadelphia, Pa., discussed meter locations for domestic services. A survey had indicated meter reading costs of 9.4c per reading of outside meters in curb boxes vs 14.9c for inside meters. Taking into account installation and maintenance, the comparison narrowed to 16c in each case—a toss-up. Costs of installation and maintenance of outside meters (including the boxes) ran to 3½ times the cost of inside installation and maintenance.

W. E. McDonald, Commissioner of Water, At Ottawa, Canada, has recently completed a universal metering program which has reduced per capita water consumption to 96 gals. More important is the fact that metering has made unnecessary the proposed filtration plant enlargement at a $2,000,000 capital expenditure saving for the present, at least.

Lining of Small Mains in Place

Another panel discussion dealt with experience in the "CLEANING AND LINING OF SMALL MAINS". R. W. Fitzgerald, Supt. of Water at Norfolk, Va., told of the cleaning and lining of large and small mains over the past several years. In one instance, 1000 ft. of 8-in. line had been lined with bituminous coating electrolytically applied. All others had been cement lined centrifugally except for 44,000 ft. of 16 inch and a 12 inch line lined by the Tate (Mandril) method. The latter with a C value of only 40 had been returned to C of 130 at a cost of 33 percent of replacement cost. The 16 in line cost was only 25 percent of replacement cost.

Frank Schwemler, Commissioner of Water, Cleveland, Ohio, presented Cleveland experiences. He told of lining 80,000 ft. of 6 to 16 inch lines with the bituminous film electroplated on the walls of the main. More recently cement-lining by the centrifugal process had been employed. The program began in 1959 and $150,000 to $260,000 had been spent annually since on lining of mains in place, at a cost of about 50 percent of replacement costs.

Lewis B. Smith, Director of Water, Rochester, N. Y., recited Rochester experiences from 1944 to date. A 38,000 ft. steel supply line had been abandoned because of leakage but was recovered through cleaning and cement lining by the centrifugal method. Since 1955, cleaning and lining of a fire-service line (6 to 20 in.) had been accomplished. On the smaller diameters, the Tate (Mandrill) Process had been employed up to recently. The most recent job had been done with the new centrifugal machine for diamters down to 6 inch, providing a 1/8th inch lining of good uniformity but a slightly rough finish, since the surface was not trowelled, as in the case of the larger lines.

With the new centrifugal machine, a great advantage and economy accrued because of the non-necessity of disconnection of service lines before lining. Lining 35,000 ft. of 6 inch main with the new centrifugal machine and applying 1/8 in. cement mortar lining resulted in return of C value to 120 for the actual (reduced) diameter, or 90 to 100 for the original diameter. In the case of 17,000 ft. of 12 in. line the respective C values were 125 for the reduced diameter and 104 if computed for the original 12 in. diameter.

In reply to questions, Mr. Smith said that the mains had to be entered only at 500 ft. intervals for the small mains, as well as the larger ones. Although the centrifugal lining with the small diameter machine looked and felt rough, the proof of its adequacy and low friction was the observation of the satifactory C values cited—90 being the lowest value for the smaller diameter lines computed from original diameters and up to 120 if figured from actual diameters.

As to the financing, the cost of main rejuvenation was chargeable to capital improvement according to the bonding company.

W. V. Weir

G. E. Arnold

J. G. Carns

W. E. MacDonald

Meter Setting Panel

M. C. Smith

R. W. Fitzgerald

Main Cleaning

The Operator's Responsibility for General Plant Maintenance

by WALLACE GRANT

Mr. Grant is Chemist for the West Virginia Water Service Co., Charleston, W. Va. His paper was presented at the 1956 Water Plant Operators' School conducted at Virginia Polytechnic Institute, Blacksburg, Va.

The cartoons were drawn by George M. Keeney, of the Engineering Department, Westvaco Chlor-Alkali Division, Food Machinery and Chemical Corp., South Charleston, W. Va.

ALMOST EVERYONE, nowadays, has had the experience of maintaining an automobile. But, there is a considerable range of practice as to how well the automobile is maintained. One person will have an oil change and general lubrication at each 1,000 miles of driving, will keep the car clean, will buy new tires when the tread of the ones on the car become thin, and, in general, will maintain the car in tiptop condition at all times. Another person may change oil and have the car lubricated at intervals of 2,000 miles or less frequently, have it washed only when the spirit (or his wife) moves him, and still be quite successful in having the car operate efficiently. And so on, to the man who never changes oil, sets his car out in the rain and hopes that will get it clean, etc.

As in maintaining an automobile, so in maintaining a water plant there are practices which range from the excellent to the very poor. Good, sound, and accepted maintenance practices for the water plant operator, and his responsibility for them, are the subject of this article.

The first principle of water plant maintenance is plant appearance [3]. A man may keep a shabby auto if he so desires, but a water plant is different in that it is a public utility and the operator has a public trust to keep it neat, clean, and operating properly. Even the smallest and most remote plant can be kept reasonably clean and neat, except during times of major repair, addition of new facilities, or extreme emergencies.

Proper maintenance is to a large extent just good housekeeping, which means keeping the building and grounds clean and attractive. Brooms and mops, used regularly, are important tools for this work. Where it can be obtained, a heavy-duty vacuum sweeper is of great assistance in keeping the plant clean. These units, which can be purchased for less than $300, can also be used as blowers when needed [7].

Dust collectors on dry feeders are of great assistance in keeping feed rooms clean.

A proper program of painting will help the appearance of the plant; it is the least expensive method of protecting and maintaining surfaces [3]. Paint pays its way in reduced corrosion and decay, when properly applied. The improved appearance is a bonus which costs nothing.

As in the case of the man who keeps his automobile neat and clean, so a water plant which is neat, clean, and orderly will probably be better maintained generally than one which is dirty, cluttered, and unattractive.

At this time It should be pointed out, however, that some plants are poorly designed, as far as keeping them clean is concerned. Dry feeders and storage for chemicals may be in the same room with the filters, or pumps, or both. In such cases it certainly requires more work and constant care to keep a plant passably clean.

Operator's Responsibility

Without question, the primary duty of a water plant operator is to run the plant correctly [4], and to serve to the city water which is safe, sparklingly clear, free of taste and odor, and reasonably non-corrosive or scale forming. However, each operator is responsible for seeing that all equipment in the plant is in good running order by devoting some of his spare time to the maintenance, or possibly repair, of the equipment.

For instance, the operator should

check pump bearings regularly for overheating; see that filters are adequately washed; make sure that the chlorinator is functioning properly, the dry feeders are in good repair, and the gauges and rate-of-flow controllers are operating; and report to the proper authority any unusual condition of any plant equipment. The maintenance duties of an operator vary according to the size of the plant in which he is working.

Small and Large Plants

In the small plant the operator is usually on his own; he must personally carry out all the general maintenance, from cleaning the plant, to lubrication, to small repairs.

In the small plant there is often a minimum of supervision, so that it is up to the operator to set up his own maintenance schedule. As many small plant operators are burdened with too great a variety of duties, the tendency is to take care of only the most pressing jobs, hoping to do tomorrow the maintenance jobs the plant needs [7]. As a result, more emergencies tend to occur in small plants than in large ones.

The small plant can get valuable assistance from manufacturers' field service men to occasionally inspect, overhaul, or repair pieces of complicated equipment of their own manufacture. Every piece of equipment needs the attention of a specialist at times. Because the manufacturer is anxious to see that his equipment runs efficiently, charges for a field service man are usually held to reasonable figures. This service is especially valuable to the small water plant.

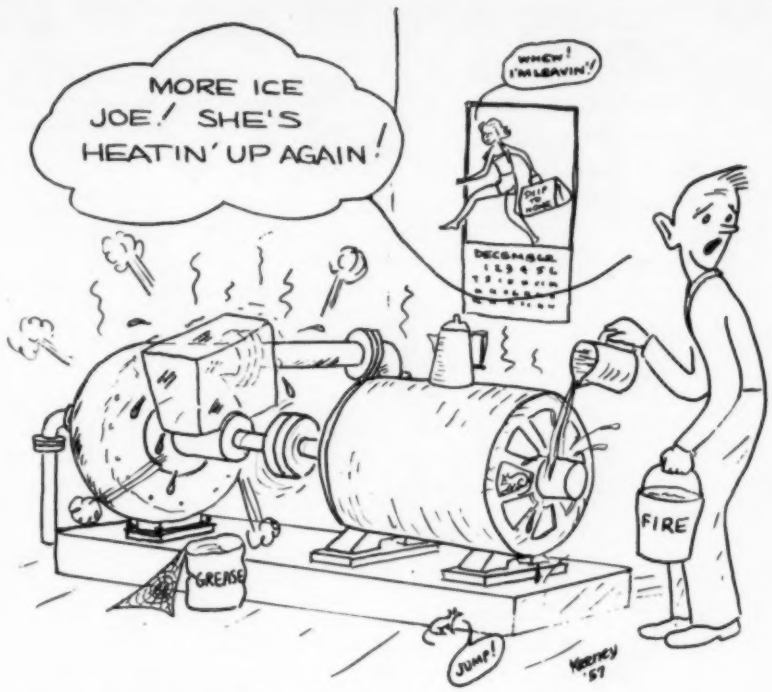
In a large water treatment plant the operator will have assistance in maintenance of the equipment. To begin with, he may have his own assistant, or assistants, who will handle the routine checks of equipment. Competent mechanics are also usually available for repair jobs and maintenance.

Variations between these two cases will be found, according to the size of the plant.

General Principles of Maintenance

Hartung and Weir [7] have summarized the principles of general water plant maintenance of equipment, as follows:

1. Any unusual sound or change in appearance should be investigated. For example, a knock in a gasoline motor, chattering in a centrifugal pump, thumping in an air compressor, or a squeak in a chemical feeder are often early signals of mechanical failure. Obviously, an operator should report any such changes that he notices. During the periodic check-ups made on each piece of equipment, however, the more critical eye and ear of a competent mechanic will often detect operating irregularities which an operator will miss.



2. Equipment must be kept clean. Moisture, dirt, dust, cobwebs, bugs, spilled oil, and so on, are definitely enemies of mechanical and electrical equipment. A vaccum-type cleaner and a compressed air line for blowing out equipment are almost "musts" for keeping equipment clean.

3. Equipment must be protected against external conditions that may cause general deterioration or damage. Open motors should be protected from dust; machinery requiring the dissipation of generated heat should be ventilated; and equipment which would be harmed by water should not be located near potentially leaking pipes, tanks or fixtures.

4. Metal subject to corrosion should be painted or kept under protective covering, nuts and bolts should be tight, etc.

5. Thermometers or surface pyrometers should be used to check temperatures according to manufacturer's recommendations, or other proven methods.

6. Vibration must be watched, and corrected if excessive.

7. Periodic tests for proper operation should be made. (Example, pump tests.)

8. Equipment must be properly lubricated; that is, with the proper lubricant, properly applied. Over-lubrication is as serious as under lubrication.

9. Wear must be watched for, and corrected if it becomes excessive.

Maintenance of Pumps

Maintenance of pumping equipment is a broad subject in itself, but here again resort is made to the automobile owner to illustrate the operator's responsibility for pump maintenance. Most auto owners are not auto mechanics; but the owner is responsible for keeping his auto in good, safe running condition. He does this by observing his car's condition and by taking it to a competent auto mechanic when anything appears to be wrong. Also, he will have an occasional check-up of his auto, such as before a long trip or vacation, to allow the mechanic to anticipate and repair any potential trouble.

In just the same way the water plant operator must keep pumps under observation and promptly report any findings. The following are some of the ideas of others on pump maintenance from the operator's standpoint:

1. The operator must be impressed with the importance of his responsibility to detect and report irregularities in the operation of a pump [1].

2. Bearing and packing temperatures are of more significance than high temperatures [1].

3. The "old timer's" criterion of whether or not he could hold his hand on the bearing is of little value in terms of modern concepts. A thermometer should be used to determine

temperatures [1]. The question then comes up as to what temperature is safe for a bearing. Lischer [1] is of the opinion that bearings can operate in continuous service at temperatures of 160°F. Many maintenance engineers don't like to have any bearing that hot, however, although present practice is that a bearing can operate safely at 50°F above room temperature.

4. When sleeve bearings are used, lack of proper lubrication will result in excessive bearing wear. Therefore, care should be exercised by the operator to ascertain that the oil in the sleeve bearing is at the proper level and to determine at frequent intervals whether or not the bearing oil rings are rotating [2].

5. If ball or roller bearings are used, the operator must overcome the natural tendency to over-oiling to prevent the high temperatures which result from the thrashing of the lubricant, particularly at high speeds. Where grease is used as a lubricant it is also possible to cause high bearing temperatures by over-dosing [2].

6. Changes in the sound of a running pump should be investigated immediately [1]. Changes in pressure or flow in the pump discharge are often an indication that something is wrong with the pump.

7. Some authorities recommend a periodic complete disassembly and overhaul of pumps, the period ranging from once each year for some raw water pumps to once in five years for finished water pumps. [1]. Others take the view that while a pump is running O. K. it should be left alone, except for routine care.

Maintenance of Motors

Dirt causes more failures in motors than any other single factor. Open-type motors should be frequently blown out with air at approximately 15 psi pressure [8]. The maintenance engineer of the author's company suggests that motors be blown out once a year. However, care must be used in blowing out a motor so that none of the accumulated dirt is blown into the bearings, as even a slight amount, especially in ball bearings, can ruin them very quickly [8].

Maintenance of Filters

Filter maintenance is the operator's prime responsibility. Although a filter could scarcely be classed as a delicate piece of equipment, it can be ruined quickly by improper washing or lack of proper care. A few years ago the author received a long distance telephone call from the mayor of a small city who wanted to know where he could buy good filter sand. He said that his city had just bought new filter sand, which he said was no good. Knowing the supplier and the filter sand they furnished, the author assured him that this company's sand was as good as any. "Well", he said, "nearly all of the sand has been washed away already." It developed that this plant was washing filters off the elevated tank in the distribution system and, obviously, too high a wash water rate was being used. The mayor was advised to consult a good engineer before more sand was purchased.

A few years before that, the author was called to a swimming pool where the complaint was that they could not keep the water in the pool clear. A glance at a glass of water from the pool showed a perfect floc. This meant only one thing—a crack or hole in the filter. When the pressure filter was opened for inspection, there was a "rat hole" about two inches in diameter right down through the middle of it. The operator was advised to rebuild his filter. In this case, the filter was washed under city pressure and some of the sand had washed away.

Some of the troubles which can be encountered in filters are (a) mud balls, which if not removed can form a compact mass of mud from the gravel to the top; (b) air binding; (c) mounds and craters on the sand surface; (d) cracks in the sand; and (e) coated sand grains.

Mud balls are formed by the gradual building up of material not completely removed in washing the filters. They tend to accumulate at or near the surface of the sand at first and usually are small. However, the author has seen mud balls of more than an inch in diameter on the surface of filters. If not removed, the compressive force of filtration causes the mud balls to clump together and form larger masses, which then sink during washing to the surface of the gravel. [4].

Inadequate coagulation and settling will sometimes so overload filters that mud balls are formed. Another cause is inadequate washing of filters. In fact, filters are more often not washed enough than overwashed. Even where wash water rates are adequate and filters are washed enough, mud balls may form if there is no surface wash. Where surface wash is not available, vigorous work with a long-handled rake by the operator during washing will keep the filters free of large mud balls. By probing around in the suspended sand with the rake, the operator can feel any hard spots in the sand. When one is found, it usually can be broken up if the rake is used each time the filter is washed.

At intervals of a year or more the top of the sand on some filters will accumulate some debris which will not wash off. It is good practice to use a broad square shovel and carefully remove this debris and a very thin layer of the top sand, which is thrown away. Boards should be laid on the sand to furnish a firm working base for the workman doing this job. After several such skimmings a little new sand should be restored to the

filter to replace that which has been removed.

In case a column of mud extends all the way to the gravel, the proper procedure is to rebuild the filter. Where this is impossible, the column can be removed with shovels and new sand replaced until such time as a rebuilding job can be done, which should be at the earliest possible time.

Air binding of filters is quite common. It results from a water applied to the filters saturated with air, which tends to come out of solution as the pressure falls a little, deep in the filter bed. An air-bound filter usually is a dirty filter. The filter should be removed from service and the air allowed to escape, allowing the water to become low on the filter sand in order to assist the air to escape. Then the filter should be washed, opening the wash water valve very slowly. If the air continues to rise after the wash water valve is just cracked it should all be allowed to escape before turning in more wash water. Turning wash water into an air-bound filter can cause a rush of water up through the gravel, which will upset the gravel, carrying some of it up into the sand.

Mounds and craters on the sand surface may be caused by an upset gravel bed, or may indicate uneven wash water caused by damage to the underdrain system.

In inspecting a filter it is a good plan to measure the wash water rise, to use a rake to feel around for hard spots in the sand when washing and, finally, to allow the water to filter completely down through the sand. If a crater forms during this filtering down, it indicates an upset gravel bed, which indicates the filter needs rebuilding.

Cracks in the filter sand may appear next to the filter wall or scattered through the sand bed. These appear to be caused by partly dirty sand, which shrinks during filtration. Here, again, the remedy is to keep the filter sand clean by adequate washing.

Wash water used equally varies from 1 to 2.5 percent of the water filtered [9]. In some plants the writer has observed, the wash water must average nearer 5 percent in order to keep the filters clean.

Coated sand grains usually result where a water from a lime-soda softening plant is applied to the sand before stability is reached with respect to calcium carbonate. However, ordinary waters deposit calcium carbonate and black manganese compounds on the sand. These will at times cause the sand grains to increase in size, until an occasional grain is as large as a BB shot. Some filter sands examined by the writer were only 40 percent sand, the remainder being coating.

Acid cleaning of badly coated sands is not economical; it is much cheaper to replace the sand. Sand just stained with manganese can be cleaned with sulfur dioxide.

Maintenance of Control Equipment

Around most water plants there is a variety of equipment, such as float controls for starting or stopping pumps, Venturi meters, rate-of-flow controllers on filters, water level gauges, pressure gauges, etc. [3].

But very few water plant operators will be qualified to repair such equipment. And even if qualified, most of them would not have the time to devote to such an intricate task. However, the operator should keep a check on how such equipment is operating and report any irregularities. Smaller plants will probably have to rely on manufacturer's representatives for an occasional repair or inspection and readjustment of such equipment.

By study and observation the operator will learn much about control equipment and in time may be able to make some adjustments and minor repairs to such equipment.

Maintenance of Chlorinators

Every plant should have duplicate chlorinating equipment, but lacking this the operator should have a good supply of spare parts in order to make rapid repairs.

The room in which the chlorinator is installed should be kept warm, not below 60°F.

Needless to say, the chlorinator should be kept clean and metal exterior parts painted. The manual of instruction furnished with the chlorinator should be studied by the operator until he has mastered the information supplied.

Maintenance of Aerators

If nozzle-type aerators are used, it is often necessary to clean the nozzles of accumulations of debris which have clogged them.

Where a cascade-type aerators are used, it may be necessary to clean them of algae growths.

Tray-type aerators need occasional attention to see that the water is passing all trays, as these can be stopped by growths and scaling from the water being aerated.

Maintenance of Chemical Feeders

Dry feeders should be calibrated and tables or curves prepared so that the operator will have available a guide for setting any desired rate of chemical feed.

Also, dry feeders should be lubricated at the regular intervals recommended by the manufacturer.

The operator should inspect the feeder several times during his shift, or plant run, to see that it is feeding properly, that the mixing chamber is supplied with adequate water, etc.

Maintenance of Settling Basins

The chief factor in maintaining a settling basin is periodic removal of the accumulated sludge. Where there is no mechanical continuous elimination of sludge, the minimum number of times that basin should be cleaned is twice a year. A record of each cleaning should be kept.

In some cases it has been known for an operator to so neglect the cleaning of a basin that it became almost full of sludge. In one case of this kind which came to the writer's attention, the operator lost his job.

Cleaning of the basins more frequently than twice a year is often necessary, and the operator should be alert to the need for cleaning the basin. In some cases, he can measure the depth of sludge; in others, he must base his opinion on other factors, such as past records, the amount of turbidity in the raw water, etc.

Summary

An effort has been made herein to show the water plant operator's responsibility toward proper general maintenance of the equipment under his control. Also, an attempt has been made to indicate where his responsibility ends and that of others begin.

In general, it may be said that a water plant is being properly maintained if the operator can proudly say: "I work here."

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Fundamentals of Applied Fluoridation

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FLUORIDATION is the practice of purposely adding to a potable water supply a specified quantity of some particular industrially prepared inorganic chemical compound containing the element fluorine, present in the compound in its reduced state as the fluoride ion.

It is not the intent to discuss the pros and cons of the addition, because there is an abundance of literature available that deals with these aspects of the practice of fluoridation. It is however, the intent to discuss applied fluoridation as related to the following:

(1) The chemical compound used in the practice of fluoridation.

(2) A graphical method that can be applied to determine the quantity and cost of each chemical compound required to impart to the water the concentration of fluoride recommended as being optimum.

(3) The mechanics involved in applying the calculated quantity of chemical compound.

(4) The type of equipment that is required to provide the mechanics for applying the calculated quantity of chemical compound.

(5) The factors involved in the selection of the particular compound that would present the most economical approach to applied fluoridation.

Fluoridation Agents

The individual chemical compounds used in the practice of fluoridation may be referred to as fluoridation agents. The agents most commonly used are hydroflusilicic acid, hydrofluoric acid, sodium fluoride, sodium silicofluoride, and ammonium silicofluoride. For purposes of discussion as related to the actual application of these compounds this list may be subdivided into two distinct groups. This subdivision, based on the physical state in which the compounds are commercially available, is as follows:

Group A: compounds commercially available in solution form:
(a) Hydrofluosilicic acid.
(b) Hydrofluoric acid.

Group B: compounds commercially available in Solid Form:
(a) Sodium fluoride.
(b) Sodium silicofluoride.
(c) Ammonium silicofluoride.

Solution form compounds are those commercially available in the form of an aqueous solution. Solid form compounds are those commercially available in the form of a dry crystalline material possessing some varying degree of fineness. The degree of fineness may range from that of a granular material to that of a powder. Table 1 lists the name, chemical formula, and other pertinent information for each of the compounds cited.

Of the agents listed, there are certain objections raised to the use of either hydrofluoric acid or ammonium silicofluoride.

The objection to the use of hydrofluoric acid is related to the hazards involved in handling this potentially dangerous chemical. Handling aqueous hydrofluoric acid requires the observance of every precaution to prevent injury and avoid accident. Therefore, its use requires the practice of extreme caution at all times and the use of proper personal protective equipment during the actual handling operation. It should be pointed out that the handling of aqueous hydrofluoric acid need not be hazardous provided its nature is understood and its dangers recognized.

The objection to the use of ammonium silicofluoride is of an entirely different nature. This objection is related to its use when the treatment practice requires the use of chlorine for the purpose of disinfection. Because the ammonium ion of the ammonium silicofluoride will react with chlorine to form chloramines, the use of ammonium silicofluoride in conjunction with chlorine may require some change in operating practice. Actually this does not adversely affect the chlorination practice, but it may affect the interpretation of the chlorine residual as related to the quantity of residual chlorine required for effective disinfection.

Related to the hazards involved in the handling of chemicals in general, it should be pointed out that any operation of handling either solution form or solid form compounds involves certain hazards. The only difference is the specific nature of the hazard involved. In handling solid form compounds the hazard is dust; in handling solution form compounds the hazard is splashing. The degree of hazard is related to the amount of dust or the concentration of the solution, and both of these are in turn related to the toxicity and/or adverse effect upon contact with the body of the chemical compound in question. In general, it should be further pointed out that all chemical compounds are toxic to some degree.

Fluoridation Agent Requirements

The first problem that confronts the individual contemplating applied fluoridation is that of determining the quantity of fluoridation agent that must be added to the water to attain the total recommended concentration of fluoride. This is generally 1.0 to 1.2 ppm. The quantity of any selected agent that will be required is dependent on the following factors:

(1) The quantity of water to be treated.

(2) The existing concentration of fluoride in the water to be treated.

(3) The available fluoride content of the commercial form of the fluoridation agent.

The first two factors are the essential operating data that must be known or ascertained for each individual installation. Calculations using this data and the available fluoride content of the commercial form of

the agent must be made to establish the requirements for any particular installation. The available fluoride content of the fluoridation agent is dependent on both the percent composition (purity) of the commercial form of the agent and the relative weights of the various constituents that comprise the pure form of the agent. Therefore, the most direct stepwise solution to the problem of determining the quantity of fluoridation agent, which is applicable to any particular treatment installation, is as follows:

(1) Determine the weight of fluoride required for the treatment.

(2) Determine the weight of the pure form of the agent needed to supply the fluoride required for the treatment.

(3) Determine the weight of the commercial form of the agent needed to supply the fluoride required for the treatment.

Although the third step in the solution to the problem may seem superfluous, it is essential because it takes into account the percent composition of the commercial form of the fluoridation agent. It is important to point out that the exact composition of the fluoridation agent will be dependent on (a) the commercial grade that is purchased and (b) the variations in the quality of each shipment. Because this information is essential to the correct solution of the problem, the determination of the exact quantity of fluoridation agent can be made only after this information is available. This should be obtained from the local commercial suppliers.

Because these calculations become laborious when conducting a survey of the requirements of each of the available agents, Figures 1 and 2 and Table 2 are presented to simplify the calculations and reduce to a minimum the time required to establish the requirements for any particular installation.

Figure 1 is used to establish the pounds of available fluoride that must be added to one million gallons of water to supply the additional fluoride required for the treatment. Figure 2 is used to establish the pounds of pure form chemical compound that must be added to one million gallons of water to supply the available fluoride required. The composition factors in Table 2 correct for purity and are used to calculate the pounds of the commercial form of the agent that are required to supply the available fluoride.

To calculate the required weight of the commercial agent, multiply the required weight of the pure agent from Figure 2 by the factor in Table 2 that corresponds to the percent composition of the commercial agent.

TABLE 1

Fluoridation Agents

(Commercial Form)

Name	Chemical Formula	Approx. Composition* %	Approx. Cost, $/lb*	Avail. F^-, lb/100 lb	Approx. Cost of Avail. F^-, $/lb
Solution form compounds:					
Hydrofluosilicic acid	H_2SiF_6	30	0.06	23.8	0.25
Hydrofluoric acid	HF	60	0.19	57.0	0.33
Solid form compounds:					
Sodium fluoride	NaF	95	0.14	42.9	0.33
Sodium silicofluoride	Na_2SiF_6	99	0.09	60.0	0.15
Ammonium silicofluoride	$(NH_4)_2SiF_6$	99	0.11	63.4	0.17

*Contact local supplier for exact values; transportation charges and container deposits not included.

Cost

Of particular interest to any community or individual contemplating applied fluoridation is the cost of the fluoridation agent required for the treatment. The actual cost of any particular agent will be dependent on:

1. The commercial grade purchased.
2. The quantity purchased.
3. The transportation cost.

To calculate the cost, multiply the number of pounds of the commercial agent required by the delivered cost per pound.

Application

The application of the fluoridation agents will require at least one and possibly two distinct operations. These operations are (a) the preliminary preparation of the fluoridation agent, and (b) feeding the prepared fluoridation agent. The form in which the agent is received from the supplier governs whether one or both of these steps will be required.

Solution form compounds are received in a physical state that is suitable for direct application; therefore, no preliminary preparation of these compounds is required (in certain cases dilution may be desired). Solid form compounds, on the other hand, must first be converted to solution form for application.

Therefore, all solid form compounds require preliminary preparation. This involves dissolving the agent in water and, ideally, requires the preparation of an aqueous solution of definite and known concentration. This operation is essential, as the quantity of the agent involved is relatively small and the specifications of the treatment are so rigid that it would be unsound practice to apply solid form compounds in the dry state.

The preliminary preparation of the solid form compounds can be accomplished with either of two basic types of equipment which are available: (a) dry feeders and mixing tanks, and (b) saturators.

The dry feeder type is designed to accurately measure a definite quantity of solid form material per unit of time. The dry material is discharged from the feeder to a solution preparation mixing tank.

The discharge from this tank should be constant and should be regulated by a float valve or other device so that the solution discharged from the tank is maintained at a definite concentration.

The feeder can be interconnected with other equipment for automatic proportioning. Dry feeders are of two general types: (a) volumetric and (b) gravimetric. The former type delivers a definite volume of dry material per unit of time; the latter delivers a definite weight of the dry material per unit of time.

A saturator is a tank into which a quantity of solid form material is placed to make a bed through which water is drawn at a low enough flow rate so that it becomes saturated with the material in the tank. The material is added by hand, intermittently, to maintain a sufficient quantity of solid form material in the tank.

The water supply to the saturator

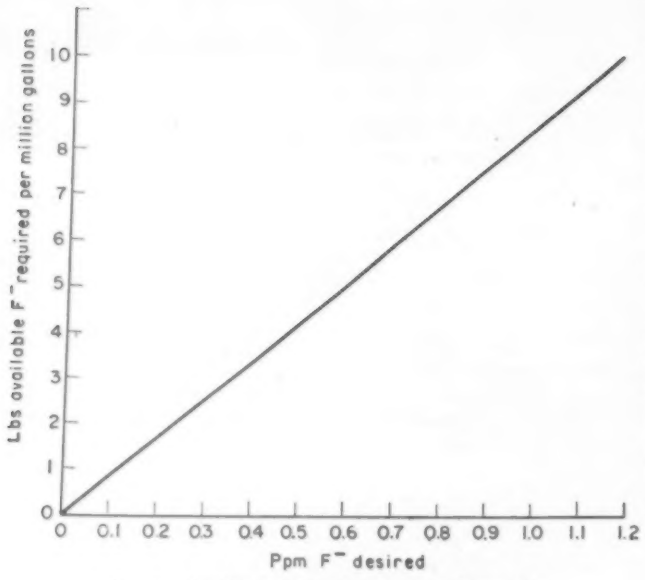


Fig. 1—**AVAILABLE fluoride ion requirements.**

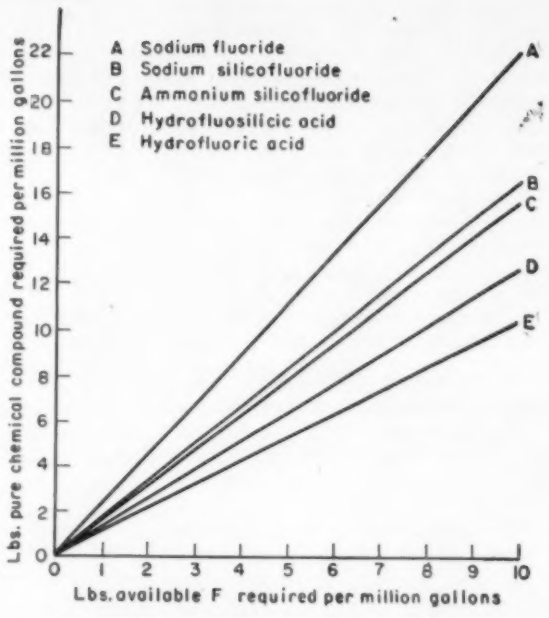

A Sodium fluoride
B Sodium silicofluoride
C Ammonium silicofluoride
D Hydrofluosilicic acid
E Hydrofluoric acid
Lbs. pure chemical compound required per million gallons
0 2 4 6 8 10 12 14 16 18 20 22
0 1 2 3 4 5 6 7 8 9 10
Lbs. available F required per million gallons

Fig. 2—**PURE FLUORIDE compound requirements.**

is generally added automatically and is either maintained constant by a float valve or is added on a controlled intermittent basis. To enhance the saturation there should be some form of agitation in the tank. Also, to prevent undissolved material from being carried over into the system, the saturated solution is withdrawn after first passing through a suitable medium such as filter sand. The saturated solution is withdrawn at a controlled and regulated rate by a suitable pump.

The second operation, feeding the prepared fluoridation agent, involves delivering a controlled and regulated volume of the aqueous solution (of definite and known concentration) to the point of application. This operation is common to either solid form or solution form compounds.

Because the quantities of solution involved are relatively small, a chemical feed type pump is generally used to perform this operation. This type is specifically designed to accurately meter and deliver small volumes of liquid. For this application, the pump must be constructed of materials suitable for handling these solutions, which are of a corrosive nature.

The method to be used for delivering a regulated volume of solution prepared from solid form compounds is dependent on both the equipment used to prepare the solution and the pressure that exists at the point of application.

For open channel feeding, using a dry feeder, the continually regulated volume of prepared solution can be fed without the use of a pump if the point of application is lower than the solution preparation tank so that it may be fed by gravity. This is possible if the design of the unit is such that the through-put rate is governed and regulated by the input to the unit. However, for closed pipeline feeding the prepared solution must be pumped into the line. Under these conditions it is essential to use a suitable pump that maintains a relatively constant rate of withdrawal.

When using a saturator, a metering pump must always be used, irrespective of the condition that exists at the point of application, to maintain a constant withdrawal rate.

Solution form compounds are much easier in handling and in adding to the water supply at controlled rates. Because these compounds are purchased at exact and concentrated strengths, their application involves only accurate metering, which can be done readily by a small metering pump directly from the container in which they are purchased.

Pertinent Application Problems

There are two pertinent problems that must be overcome in the application of the fluoride solution.

The first problem is related to the method of uniformly applying and adequately dispersing a small volume of solution at the point of treatment. The most accurate means available for metering this volume of solution is a chemical feed pump. This type of pump is extremely accurate for metering a small volume of solution; however, its basic principle of operation involves a piston-type action. This principle by nature produces a pulsating effect in the stream of solution being discharged from the pump. This pulsating effect gives rise to an uneven and discontinuous application at the point of treatment. At best, it provides an intermittent application of the fluoride solution, or slugging. In addition to this, the quantity of solution is so small that good dispersion is practically impossible.

The second problem is related to the possibility of syphoning the fluoride solution from the source of supply, due to direct connection to the main, in the event that a vacuum is created at the point of injection. This could occur as a result of pipeline breakage, abnormal hydraulic conditions at the point of application, check valve failure, etc.

There are a variety of systems that have been used in an attempt to eliminate these two problems of assured continuous uniform and safe application of a fluoride solution.

One type of system entails the use of two pumps with an additional solution mixing tank. The one pump is a metering pump, which is used to accurately meter the concentrated fluoride solution to the second tank, into which dilution water is continuously added. This diluted solution is in turn injected into the pipeline by a second pump, which is of the higher capacity turbine or centrifugal type.

Because the discharge of the pri-

mary metering pump is allowed to feed open to the second tank, the problem of syphoning is minimized to the capacity of the second solution tank. Dispersion has been improved by the continuous injection of the larger volume of dilute solution. With this system, the second solution tank and the secondary pump must also be constructed of corrosion resistant materials. This adds further cost to the installation and maintenance of the system.

Another type of system which is used to improve dispersion, but does not eliminate the possibility of syphoning, consists of a pipe section in parallel with the mainline pipe. The inlet and outlet of this parallel pipe section must be placed across a restriction in the main line that will cause a low-velocity flow through this section. The restriction may be a pipe fitting, valve, or other mainline restriction, or may be artificially produced by a pitot tube arrangement.

The concentrated fluoride solution is injected into the upstream end of the parallel pipe section. The low velocity of flow at the point of application provides a reasonable degree of dispersion. Although this system reduces the effect of slugging, it does not positively eliminate it. Also, experience has shown that a corrosion problem is encountered in the parallel pipe section unless suitable materials of construction are used again making for added cost in both installation and maintenance.

Another system used eliminates both these problems and deserves special comment both from the standpoint of simplicity of design and positive safety features. This system was developed by Kalamazoo, Mich., which began fluoridation in 1950. During the initial months of this program they obtained daily test results that indicated a variation in fluoride concentration, which was at first attributed to inaccuracy of the feeding equipment. Tests later proved this variation to be caused by the slugging of fluorine solution due to the characteristic pulsating discharge from the chemical feed pump.

The Kalamazoo Water Department then began experimentation to devise a system which would eliminate this variation in concentration as well as eliminate the possibility of syphoning. The system devised involves use of the existing chemical feed pump to feed hydrofluosilicic acid into a small mixing and dilution tank. The metered acid is discharged into the top of the tank, into which dilution water is added at a regulated rate.

The constant strength dilute solution is withdrawn from the bottom of the tank and injected into the main line using a water ejector. This diluted solution is withdrawn from the bottom of the tank by the vacuum created in the ejector and is further diluted by the water flowing through the ejector. Excellent dispersion is attained, as this dilute solution is discharged to the point of application continuously.

The dilution tank is designed to maintain a constant volume of dilute solution and to automatically and positively maintain a constant rate of withdrawal. An air break between the pump discharge line and the top of the dilution tank positively eliminates the possibility of syphoning concentrated fluoride solution into the treatment system.

Solubility Factor

The physical property of the fluoridation agent which affects the use of solid form compounds is solubility. The solubility of any solid form compound is dependent on (a) the temperature of the solution water and (b) the time of contact allowed between the compound and the solution water.

The potentially adverse effect of each of these factors can be eliminated by proper design and adequate temperature control (again at added installation and maintenance cost). The time factor can be overcome by proper mechanical design so that the flow rate is low enough to insure sufficient dissolving time at the operating temperature. The temperature factor can be overcome by providing adequate temperature control for the chamber in which the solid material is dissolved.

The solubility factor dictates the quantity of water that is required to dissolve a unit weight of any solid form compound at some specified temperature. Therefore, in effect, it dictates the minimum quantity of aqueous solution of the solid form compound that must be prepared and subsequently metered to the point of application by the chemical feed pump.

Although the exact quantity of solution that would be required is dependent on the selected operating conditions, the relative volumes required to contain one pound of available fluoride are shown pictorially in Figure 3. In the interest of comparison, the volumes of hydrofluoric acid and hydrofluosilicic acid required to contain one pound of available fluoride are also shown. The volume of each of these acids is independent of the operating temperature, as they are purchased in solution form.

It is essential to point out that without adequate temperature control, difficulty in maintaining a controlled operation may be experienced with the use of solid form compounds. Should the temperature of the water fall below the required minimum in the solution preparation mixing tank, undissolved material will pass from

TABLE 2

Composition Factors of Fluoridation Agents

% Comp.	Factor	% Comp.	Factor	% Comp.	Factor	% Comp.	Factor
100	1.000	80	1.250	60	1.666	40	2.500
99	1.010	79	1.266	59	1.695	39	2.564
98	1.020	78	1.282	58	1.724	38	2.632
97	1.030	77	1.299	57	1.754	37	2.703
96	1.042	76	1.316	56	1.786	36	2.778
95	1.053	75	1.333	55	1.818	35	2.857
94	1.064	74	1.351	54	1.852	34	2.941
93	1.075	73	1.370	53	1.887	33	3.030
92	1.087	72	1.389	52	1.923	32	3.125
91	1.099	71	1.408	51	1.961	31	3.226
90	1.111	70	1.429	50	2.000	30	3.333
89	1.124	69	1.449	49	2.041	29	3.448
88	1.136	68	1.471	48	2.083	28	3.571
87	1.149	67	1.493	47	2.128	27	3.704
86	1.163	66	1.515	46	2.174	26	3.846
85	1.176	65	1.538	45	2.222	25	4.000
84	1.190	64	1.563	44	2.273	24	4.167
83	1.205	63	1.587	43	2.326	23	4.348
82	1.220	62	1.613	42	2.381	22	4.545
81	1.235	61	1.639	41	2.439	21	4.762

the tank to the point of application. Obviously this could give rise to a potentially hazardous condition.

With a saturator tank any variation in temperature will cause a corresponding variation in the concentration of the solution entering the point of application and will result in inaccurate dosage of fluoride. Of the two solution preparation systems, adequate temperature control is more critical when using the saturator.

Of the two more commonly used solid form compounds, adequate temperature control is more critical with the use of sodium silicofluoride than with sodium fluoride, because the former has a wide range of solubility over the normal range of operating temperatures. However, the absence of adequate temperature control using either of these mechanical methods for the preparation of aqueous solutions of the solid form compounds presents undesirable and potentially adverse conditions in the treatment operation.

Another factor that must be taken into consideration when considering the use of sodium silicofluoride is its corrosive nature: a saturated solution has a pH of 3.5 to 4.0. Saturated solutions of sodium fluoride, on the other hand, will normally have pH values slightly on the alkaline side. Therefore, materials more highly resistant to corrosion must be used for handling solutions of sodium silicofluoride.

Chemical Factors

The chemical property of the fluoride ion which affects the application operation is its potential to react with certain other ions present in the water, forming insoluble compounds. This property will affect the solution preparation operation and the selection of the point of fluoride application.

In respect to the solution preparation operation, the solid form compounds are primarily affected. Inasmuch as solid form compounds must be dissolved in water, any interfering ion present in sufficient concentration will react with the fluoride ion to form an insoluble fluoride compound. For example, calcium and magnesium ions present in sufficient concentration will react with the dissolved fluoride ions to form insoluble calcium fluoride and insoluble magnesium fluoride.

Should precipitation occur in this operation, insoluble fluorides may pass into the treatment system. Once in the system they may settle out in the low points in the distribution system, where they may cause plugging and increase water main maintenance. If they should (due to unusual conditions) re-dissolve, it would occur in a random manner, causing fluctuations to occur in the fluoride ion concentration throughout the system; or they might pass through in slugs, causing an even more undesirable condition.

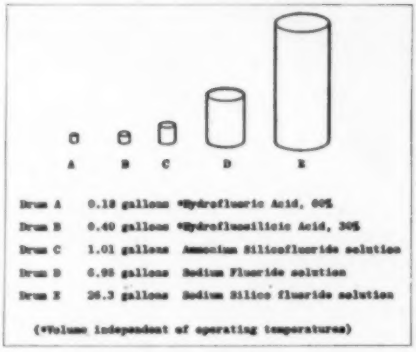

A
B
C
D
E
Drum A 0.10 gallons *Hydrofluoric Acid, 60%
Drum B 0.40 gallons *Hydrofluosilicic Acid, 30%
Drum C 1.01 gallons Ammonium Silicofluoride solution
Drum D 6.95 gallons Sodium Fluoride solution
Drum E 26.3 gallons Sodium Silico fluoride solution
(*Volume independent of operating temperatures)

Fig. 3—RELATIVE VOLUMES of aqueous solution to contain 1 lb of available fluoride; solution temperature approximately 60°F.

This precipitation reaction will occur at any time the individual concentrations of the fluoride ions and the interfering ions exceed the limiting concentrations. As such, the occurrence of the reaction is dependent on varying relative concentrations of each; therefore, the limiting concentration of each of the interfering ions in the solution water is dictated by the concentration of the fluoride ions in the fluoride solution, or vice versa. In cases where the minimum concentration of fluoride ion required to make a solution preparation operation practical gives rise to the production of insoluble fluorides, the solution water must be treated to reduce the concentration of the interfering ions to the limiting value.

In such cases, this would increase the over-all cost of the fluoridation operation, both from the standpoint of providing adequate solution water treatment facilities and the continued operating cost of the treatment. Both these costs are related to the quantity of solution water that would have to be treated and this in turn is related to the solubility of the selected solid form compound.

Because these interfering ions are constituent ions of several of the water treatment chemicals, the point of fluoride solution application must be carefully selected at those installations also using chemical treatment. At such installations, the fluoride solution should not be applied prior to any treatment operation designed to remove undersirable constituents by either coagulation, precipitation, or absorption. The simple rule to remember is that any treatment designed to remove other substances will usually remove fluorides. Following this rule, the fluoride solution should be applied as the final step in the treatment before the water is discharged to the distribution system.

Chlorination used for the purpose of disinfecting the water in the final step in the treatment will not remove fluoride. Because there is no chemical reaction that occurs between chlorine and fluoride, these substances can be added simultaneously to accomplish purification and fluoridation in one operation prior to discharging the water to the distribution system.

Selection of Fluoridation Agent

The selection of the particular fluoridation agent to be used in the fluoridation operation is, in the final analysis, made after a comparison of the over-all cost picture for each agent. This picture is divided into two parts; namely, (a) the immediate cost, which is the initial cost of the equipment including installation charges; and (b) the operating cost, which includes the equipment maintenance cost, the chemical cost, and, when considering solid form compounds, the solution preparation cost.

After taking all cost factors under consideration, it will become obvious that, generally speaking, the use of a solution form compound is, in the long run, more economical than the use of a solid form compound.

In addition to the definitely lower installation and operating costs associated with the use of solution form compounds, they offer additional practical operating advantages. These advantages are:

1. They are purchased at exact solution strength.
2. They require no preliminary preparation.
3. Their use involves simply direct feed from the container in which they are received.
4. Their lower handling requirement provides greater safety to operating personnel.

On the other hand, solid form compounds, although purchased at exact composition, cannot be fed directly into the system without some preliminary preparation. This preparation is not only costly but also invloves constant supervision to control the two variables associated with the operation. At best the use of solid form compounds is troublesome from a practical operational viewpoint.

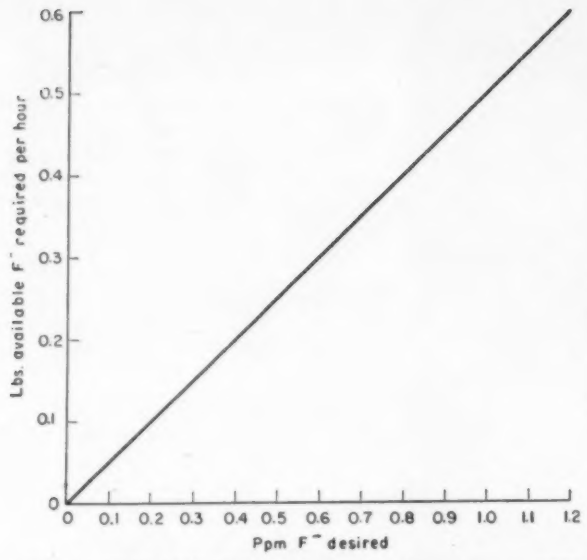


Fig. 4—AVAILABLE FLUORIDE ion requirement per 1000 gpm flow rate.

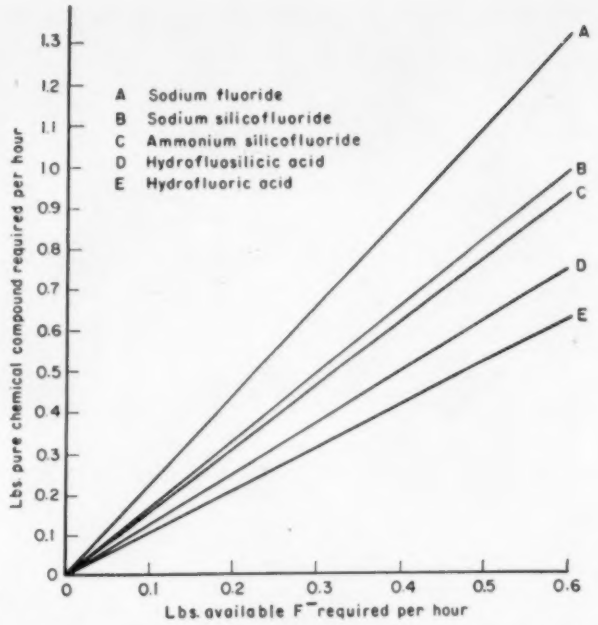

A Sodium fluoride
B Sodium silicofluoride
C Ammonium silicofluoride
D Hydrofluosilicic acid
E Hydrofluoric acid
Lbs pure chemical compound required per hour
Lbs. available F⁻ required per hour

Fig. 5—PURE FLUORIDE compound requirements per 1000 gpm flow rate.

It is sound reasoning based on fundamental, technical, and engineering principles that gives the corollary: "It is always easier to feed a prepared solution than to prepare a solution for feeding." This corollary holds true for any application of a chemical compound that must be exactly proportioned to the quantity of water being treated.

It is this reasoning that is the basis of the recommendation that solution form compounds should be used in applied fluoridation. Further, recognizing the greater degree of hazard associated with the use of hydrofluoric acid as compared to hydrofluosilicic acid, it is further recommended that first consideration be given to hydrofluosilicic acid. It is recognized that there will be instances where the relative transportation costs will prohibit the use of either of the solution form compounds and in such cases the use of adequate temperature control is required to maintain uniform concentration of the fluoride solutions prepared from solid form compounds.

Safety Measures

As a protection against dust, the operator should wear a dust respirator, a transparent eye shield, and rubber gloves when handling solid form compounds. When handling solution form compounds a transparent eye shield and rubber gloves should be worn as a protection against splashing.

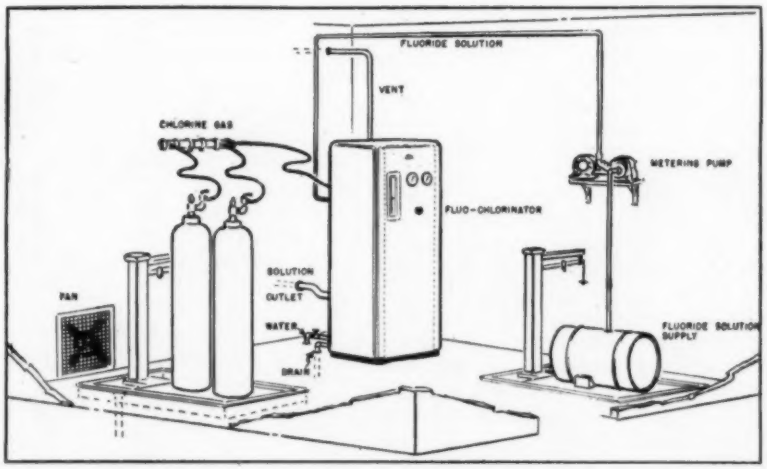
Although the feed hoppers of some dry feeders are equipped with a dust collector, dusting can be greatly reduced by the careful handling of the dry material during the filling operation. The same hazard can also be greatly reduced when filling a saturator, by slitting the top of the bag and emptying the contents while the open end is immersed beneath the surface of the water. The usual precaution of washing the hands after each filling operation is a good safety practice to be followed.

Sampling and Testing

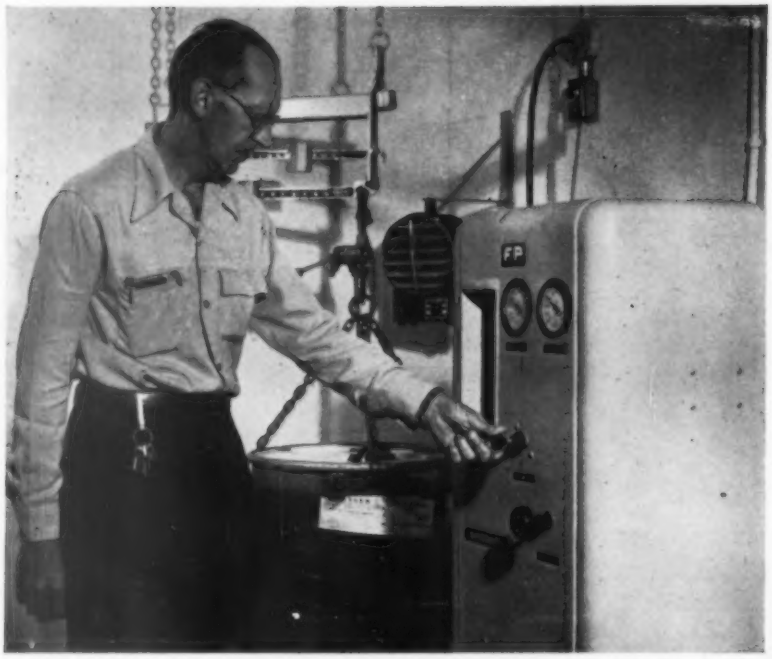
An important phase of applied fluoridation is the determination of the quantity of fluoride ion present in the water, both at the plant and at selected points throughout the distribution system. This information must be obtained and recorded at any plant practicing fluoridation.

The standard tests* used to determine the quantity of fluoride are based on the reaction between fluoride ion and the zirconiumalizarin lake in an acid solution. The color resulting after a definite time of contact is dependent on the quantity of fluoride present in the sample under test. The

*Standard Methods for the Examination of Water, Sewage and Industrial Wastes," 10th Edition, Amer. Pub. Health Assn., New York, N. Y. (1955)



INSTALLATION diagram of a Fischer & Porter fluo-chlorinator system.



SINGLE MACHINE performs double duty as simultaneous chlorinator and fluoridator.

intensity and hue of the color is either measured photometrically or compared visually with color standards. The visual comparison can be made using permanent color standards and commercial slide comparators, or by preparing color standards at the time of test and making the comparison with the use of Nessler tubes.

The accuracy of the test is affected by the presence of certain other ions, which may be present in the water in sufficient concentration to interfere with the intensity and hue of the final color. In some water supplies this interference can be eliminated by diluting the sample with water; in others the sample must first be distilled, the test being made on the distillate. However, using careful technique and taking steps to reduce or eliminate the concentration of interfering ions, the fluoride ion concentration can be determined with a high degree of accuracy.

Determination of Quantity and Cost

As previously stated, the determination of the exact quantity and cost of the fluoridation agent for any particular treatment installation is dependent on factors that are governed by circumstances. However, in the interest of completeness of presentation, the percent composition and the costs shown in Table 1 can be used to arrive at a very close approximation of these values. Briefly, this involves four distinct steps, in the order given:

Step I: Determine the weight of fluoride required.

Step II: Determine the weight of the pure form of the agent needed to supply the fluoride.

Step III: Determine the weight of the commercial form of the agent that must be added.

Step IV: Determine the cost of the agent.

A practical illustration will demonstrate the effectiveness of the systematic use of the graphs and tables in obtaining the rapid solution to a problem. (Hydrofluoric acid and ammonium silicofluoride have not been included, but would be calculated in the same manner.)

Illustrative Problem

The authorities of a municipal water treatment plant supplying 0.96 million gallons of water per day wish to fluoridate the entire supply to a total concentration of 1.0 ppm fluoride. The analysis of the water shows the existing fluoride concentration to be 0.1 ppm. They are interested in knowing the weights and comparative costs of each of the agents required to be added to the water each day to attain the desired fluoride concentration.

Solution:

Step I: Determine the weight of fluoride required.

The ppm fluoride that must be added are:

1.0 ppm — 0.1 ppm = 0.9 ppm

Referring to Figure 1, the fluoride which must be added per million gallons to obtain 0.9 ppm = 7.5 lb.

Step II: Determine the weight of the pure form of each agent needed to supply the required fluoride.

Refer to Figure 2 and multiply the values obtained for 1 million gallons by 0.96

Hydrofluosilicic acid .....
9.4 lb x 0.96 = 9.02 lb

Sodium fluoride .....
16.5 lb x 0.96 = 15.84 lb

Sodium Silicofluoride .....
12.3 lb x 0.96 = 11.81 lb

Step III: Determine the weight of the commercial form of each agent that must be added.

Referring to Tables 1 and 2, these weights are:

Hydrofluosilicic acid, 30% .....
9.02 lb x 3.33 = 30.04 lb

Sodium fluoride, 95% .....
15.84 lb x 1.05 = 16.63 lb

Sodium silicofluoride, 99% .....
11.81 lb x 1.01 = 11.93 lb

Step IV: Determine the cost of each agent.

Referring to Table 1, this is:

Hydrofluosilicic acid .....
30.04 lb x 0.06 = $ 1.80

Sodium fluoride .....
16.63 lb x 0.14 = $ 2.33

Sodium silicofluoride .....
11.93 lb x 0.09 = $ 1.07

Many communities obtain their water from ground water supplies using deep well pumps. This water may be pumped directly into the distribution system.

The output from each well may be treated separately, or the combined output from several wells may be treated. In the case of separate treatments the equipment is generally located in the pump house, for combined treatment the equipment may be located in one of the pump houses or at some centralized point.

Depending on the size of the community and the location of the wells, there may be one or more treatment installations. Because the water treatment depends on the flow rate, and deep well pumps are normally rated in gallons per minute, Figures 4 and 5 are presented as a convenience in calculating the requirements for installations of this nature. All calculations using these graphs follow the same stepwise procedure as outlined and presented in the illustrative problem.

About Dog Days — And Such!

An open letter from one superintendent to another

Dear Bill:

When we were youngsters, this time of year (late July and August) was known as "dog days". I never quite knew why—something to do with Sirus, the dog star, or the time when dogs went mad and bit little children, or the season for dog fennel to be in bloom—or something. I did know, however, that it was time of year when the "ole swimming hole " turned green with scum and got stinky. We kids weren't allowed to go swimming then, because we "might get sick".

In our case there were two swimming holes: Deerfoot, sometimes called "eightfoot", (because of the depth of the river there) and the commercial Byer's Beach. Deerfoot was just around the first bend in the river above the water works dam, less than a mile above the intake for the filter plant. It drew the barefoot boys—bare skinned, too—to its diving tree, a dead and barkless old oak, with only a few stumps of the larger branches remaining to give it the appearance of deer antlers—the name was a corruption of deer head and eightfoot. The commercial beach, some 2½ miles upstream from the dam might draw 50 persons a day during the week and several times that many on week ends.

It was done some years after my early swimming days that I learned that the water works was as unhappy to see that green scum as we kids were, for that scum was algae bloom and the pigpen odor was caused by Anabaena. I learned, too, that some well distributed copper sulfate in the river reservoir would control that algae bloom, much to the delight of the current crop of swimmers and the people who drank the water.

Recreational Use of Reservoirs

All this came to mind—how we used to swim in the water works impounded reservoir—when I listened to a couple of papers at the AWWA meeting in Atlantic City in May. One paper, by Dan Morse, Vice Pres. and Gen. Mgr. of the Indianapolis Water Co., told how they had provided boating (no swimming) facilities on one of their reservoirs. John McFarland, Gen. Mgr. of the East Bay Munic. Utility Dist. in Oakland, Calif. said he hoped that Dan's paper didn't get published west of the Rocky Mountains.

Seems to me that this subject of public access to impounding reservoirs has been on the controversial agenda at AWWA meetings for some time. It seems, too, that water supplies in the mid-west are more lenient toward the matter than other areas. Typical of the mid-west attitude, besides Indianapolis, are Danville, Decatur, Springfield and Bloomington, Ill. In all these cases, impounding reservoirs exist on surface supplies on streams of relatively low normal flow; all of them have complete purification plants.

In areas where the water supply comes from upland sources and the water is delivered untreated to the customer, it is understandable that the consumer might be a bit squeamish about drinking water that someone had been swimming in, but for other uses—I don't know. For people, who have been drinking treated and purified water from surface streams, the problem is not so acute; they have a healthy respect for the efficient and effective operation of the water purification plant—and they see nothing wrong in using the water works reservoir for recreational purposes, if it's properly done. Remember too, in these localities, where water works reservoirs are put to such use, there is generally no other body of water in the area for recreational use.

Fluoridation

I guess it's all in what you get used to. In that respect it's like the matter of fluoridation.—People who have been drinking water containing natural fluorides all of their lives, don't seem to "holler" half so much as some other people.—You know, there's one thing that has always bothered me about this fluoridation controversy, which also popped up at the AWWA Convention; and that is this: It is well known that tea contains lots of fluorides; I understand that one good cup of tea may contain up to many, many times as much fluoride as you'd get if you drank your full quota of eight glasses of fluoridated water a day. If that is so, how come the English and Chinese peoples haven't succumbed to all of these dire things that the antifluoridationists predict for fluoride water drinkers.

Purification Control

To get back to these impounded water supplies and their use without treatment. I've always felt a little sorry for the men who work in that type of supply. They haven't really lived.—Not until you've run a water works on a flashy stream where the turbidity can go from practically nothing to 24,000 ppm in a few days, or from zero to 1000 ppm in a few minutes; not until you've tried to coagulate water at temperatures from freezing up to 90 deg. F.; not until during dog days and drouths, you've gone up the river bed digging a channel from pool to pool to let down enough water for one more day; not until the stream has overflowed its bank and put your plant out of commission; not until you've rowed sacks of blue vitriol around your reservoir 'til your hands were so blistered you couldn't hold the oars; et cetera, et cetera, et cetera.

But pshaw—now flood control, larger reservoirs, clever machines for distributing copper sulfate and so forth are taking all those problems out of "waterworksing"—Why now, I understand that down at the Univ. of Florida, Dr. Black and Dr. Buswell are studying automatic means of controlling the proper dosage of coagulant. That's the next big step in automation. We already have automatic filter control, automatic backwashing of filters, automatic pump control, automatic pacing and remote control of chemical feeders, etc. And more's coming.

Where's the romance of running a filter plant going to be soon, with all this push button operation and automation. Where will be the long hours, the headaches, the backaches and the heartaches of yesteryear.—Gone, for good, I hope.—And with them, I hope, will go the ridiculously low wages for water works men and the low water rates which have held back our progress for so long.

I sure go along with John Murdoch on his statement that we have had too cheap water, too long. Maybe, this evil, too, is on the way out as these other new ideas come in. Well, enough of dog days and reminisces. I'll see you at the next section meeting.

Yours, Herb

WATER WORKS PRACTICES

Corrosion—Part II, Continued

More Methods of Control

The forty-first of a series

The previous installment of "Corrosion—Part II" on "How to Combat it", appeared last month and covered two methods of control: Use of non-corrosive materials and protective coatings. This installment will complete the subject of methods of control.

by GEORGE E. SYMONS, Ph. D.

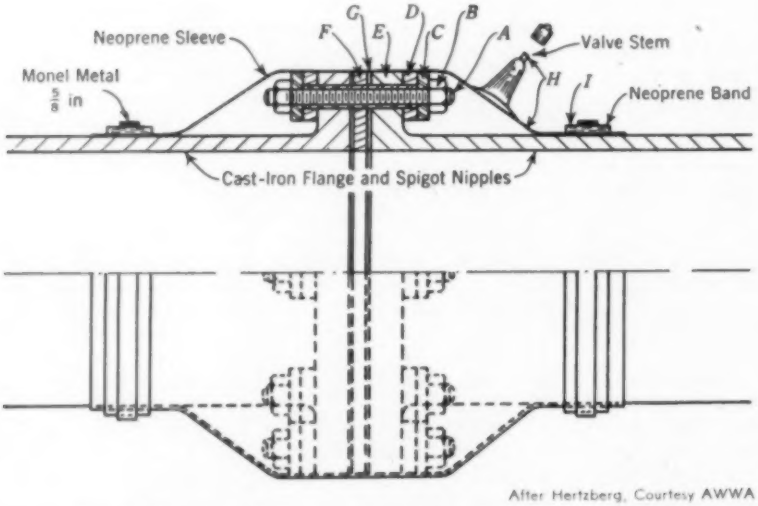
In this series, Dr. Symons discusses water works practices in the form of short school lectures, designed to assist operators, students, and others who wish to review fundamentals in this field.

H . . . Insulation and Bonding

1 . . INSULATION

a. The purpose of insulation is to create a resistance to electrical current flow, particularly to prevent galvanic action between dissimilar metals as well as to prevent the effect of stray electrical currents.

b. Insulation finds its greatest use for protection against underground corrosion in areas where soil conditions are extremely corrosive.



After Hertzberg, Courtesy AWWA

Fig. 4.—DETAILS of Cast-Iron Insulating Joint, ASA Class 125

Flange drilling is in accordance with ASA class 125. For pipe sizes 4 to 8 in., flange and spigot nipples of 18-in. length should be used. For pipe sizes of 10 to 16 in., 24-in. lengths should be used. The monel metal shown is banding.

c. Methods of insulation include insertion of insulating joints between dissimilar metals and the use of insulating joints to prevent the flow of strays currents.

(1) For mains, various types of insulating joints include special cast iron or steel insulating flanges, asbestos-cement nipples, or insulating sleeve couplings. An example is shown in Fig. 4.

. . . On valves, bakelite and steel washers may be used between the valve flange and valve body.

. . . Neoprene sleeves are used to cover these insulation joints on large lines.

(2) Nylon is used for insulating bushings where copper service lines are connected to steel mains.

d. Paints and other protective coatings are a form of insulation.

e. An excellent "Nontechnical Manual" on insulation and bonding as a means of corrosion control was published by L. B. Hertzberg in *Jour. AWWA* Vol. 48, No. 6, p. 719 (1956)

2 . . BONDING

a. Bonding is used to combat elec-

Ed. Note: Dr. Symons is Exec. Vice President and Editorial Director of Scranton Publishing Co., Inc.

trolysis when stray electric currents flowing between adjacent pipelines or structures develop unsafe voltages.

b. According to Hertzberg, a copper cable connecting pipe sections is "installed to provide a low resistance path for the current and to reduce the voltages to safe values.

c. Bonding finds its greatest use in corrosive soils, where external corrosion is a great problem.

d. The subject of stray currents always raises the question of the propriety of grounding house electrical circuits to water pipes as a safety measure.

(1) When done according to proper standards, grounding has not caused damage to pipes, quality of water, property, or life.

(2) One of the restrictions to the practice of grounding is that only secondary distribution circuits of alternating current may be grounded to water pipes.

. . . An electrical jumper should be connected around the water meter.

I . . . Deactivation

1 . . Definitions

a. Deactivation is the term applied to the removal of dissolved gases from water, with particular reference to the removal of oxygen, carbon dioxide, and hydrogen sulfide.

d. Deaeration is the term applied to the removal of dissolved oxygen from water. It is generally applied to physical rather than chemical means of removing dissolved oxygen.

2 . . Dissolved Oxygen Removal

a. Removal of dissolved oxygen may be accomplished in several ways.

(1) Cold water vacuum deaeration may be accomplished by subjecting the water to a reduced pressure or vacuum of 28 to 29 inches.

. . . Best results are obtained if the water passes through the deaerator in thin films over slats (See Fig. 5), or gravel. The temperature of the water affects the results obtained.

. . . Experiments at the University of California indicated that if water at 70°F trickles through a 20 ft layer of coarse gravel in a tank, at a pressure of 1/30 atmosphere, the dissolved oxygen content will be reduced to about 10 per cent of saturation, at a rate of 3500 gpd per cu ft of tank volume.

(2) Hot water deaeration is usually practiced in conjunction with the preparation of boiler water.

. . . Open heaters, particularly spray types, will reduce the dissolved oxygen content to 0.1 to 0.2 ppm, if the water is brought to a temperature of 208°F or so, by steam.

. . . Atomizing and tray type deaerating heaters are also used.

(3) Removal of dissolved oxygen by chemical reaction may be accomplished by adding a chemical with a great avidity for oxygen. This method is often employed in connection with boiler waters, but it has also been used in industrial water supplies as well to protect long pipe lines.

. . . The most commonly used deoxygenator is sodium sulfite, often employed to remove residual dissolved oxygen after other deaerating methods.

. . . The chemical reaction is

$$O_2 + 2Na_2SO_3 = 2\ Na_2SO_4$$

and the amount of sodium sulfite needed is approximately 8 parts of sulfite for each part of oxygen to be removed.

. . . This reaction is much more rapid at elevated temperatures. At normal temperatures, a catalyst (a copper or cobalt salt) speeds the reaction.

(4) Dissolved oxygen can also be removed by passing the water over iron turnings. This is not practical for large volumes of water and also results in some iron pickup by the water.

(5) Dissolved oxygen can be removed from water by sweeping or stripping it out with nitrogen gas, but this method is not economically feasible in practical applications.

3 . . Carbon Dioxide Removal

a. Carbon dioxide will be removed along with oxygen in vacuum deaerators.

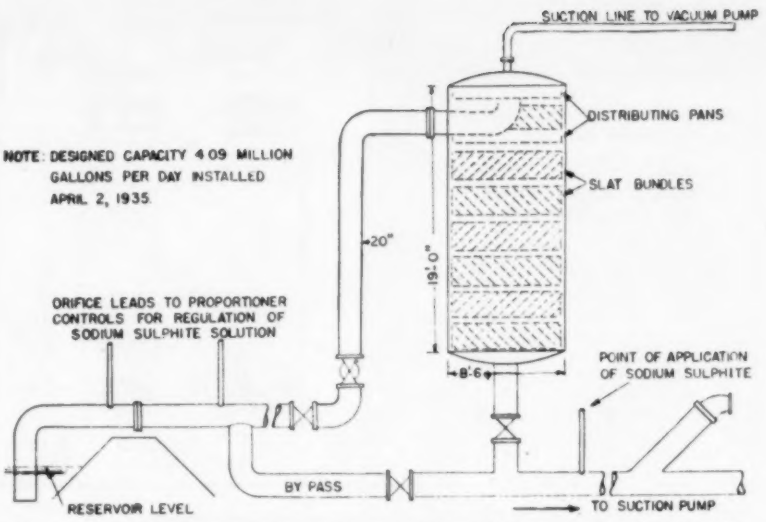

SUCTION LINE TO VACUUM PUMP
DISTRIBUTING PANS
SLAT BUNDLES
NOTE: DESIGNED CAPACITY 4.09 MILLION GALLONS PER DAY INSTALLED APRIL 2, 1935
20"
19'-0"
8'-6"
ORIFICE LEADS TO PROPORTIONER CONTROLS FOR REGULATION OF SODIUM SULPHITE SOLUTION
POINT OF APPLICATION OF SODIUM SULPHITE
BY PASS
RESERVOIR LEVEL
TO SUCTION PUMP

Fig. 5.—DESIGN for deaerating tank and slat packed tower construction for Grande Ecaille Mine of Freeport Sulphur Co.

b. Carbon dioxide in ground waters can be removed by aeration in any type of aerator, but the value of this treatment is somewhat dubious since the dissolved oxygen introduced into the water may have a greater effect on corrosion than small amounts of carbon dioxide.

c. Carbon dioxide can also be removed by passage of the water over limestone. This is a chemical rather than a physical treatment process and will be described later.

4 . . Hydrogen Sulfide Removal

a. Hydrogen sulfide present in ground waters will react with iron to create corrosion effects; it may be removed mechanically by vacuum deaerators or by aeration.

b. Hydrogen sulfide can also be removed by chemical treatment as described later.

5 . . Economics of Deactivation

a. The process of vacuum deaeration has generally been considered as too expensive and involving too many control problems to be used as a means of reducing pipe corrosion in municipal supplies.

b. Thesis studies at the University of California in 1938 and 1943, indicated that the cost of partial deaeration to reduce corrosion to a satisfactory level was in line with other forms of treatment.

c. Powell—*Wat. & Sew. Wks.*, 93: 93(1946)—described the single stage vacuum deaerator shown in Fig. 5, which was installed at Port Sulphur, La., and estimated the cost of a single

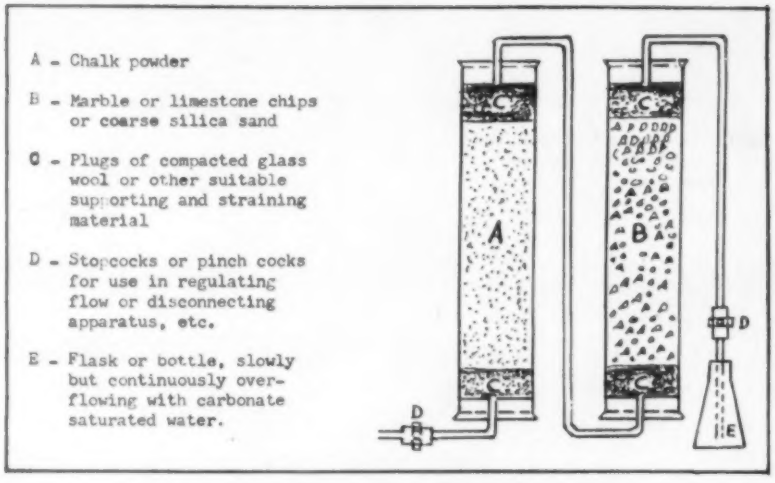

A - Chalk powder
B - Marble or limestone chips or coarse silica sand
C - Plugs of compacted glass wool or other suitable supporting and straining material
D - Stopcocks or pinch cocks for use in regulating flow or disconnecting apparatus, etc.
E - Flask or bottle, slowly but continuously overflowing with carbonate saturated water.
A
B
C
D
E

Fig. 6.—CONTINUOUS stability indicator design.

Tube B functions as a trap for sweeptover chalk powder; also colloidal chalk if present will plate out on the grains.—From flask E, portions are drawn for comparison of alkalinity and pH with influent water.

stage deaerator plant at $10,000 (1946 prices) for a capacity of 1000 gpm.

(1) For each 1000 gpm additional up to 5000 gpm, the additional equipment cost was estimated at $3500.

(2) Multiple stage units are more costly to install.

d. The cost of original equipment and operation both increase rapidly the higher the vacuum to be maintained, but the higher vacuum is required if the amount of residual dissolved oxygen is to be kept at a very low value.

(1) Less costly operation is possible if the vacuum maintained is on the order of 25 to 28 in. of mercury.

(2) Further reduction of dissolved oxygen can be obtained at lower total cost of operation by adding a deoxygenating agent such as sodium sulfite, as described above.

J . . . Chemical Treatment

1 . . Chlorination

a. Biofouling of water pipes not only results in lowered carrying capacity but also creates corrosive conditions.

b. Chlorination of water supply to produce a small concentration of residual chlorine in the distribution system will minimize corrosion due to biological activities.

(1) The killing of sulfate splitting bacteria will prevent the formation of hydrogen sulfide and its attendant reaction with iron.

(2) Biochemical corrosion generally occurs in water devoid of oxygen but containing appreciable amounts of organic matter.

. . . It can also occur in water containing dissolved oxygen. In this case, biological growths on pipe lines decompose at the point of contact with the pipe, and create an anaerobic condition which results in corrosion.

2 . . Hydrogen Sulfide Removal

a. Since hydrogen sulfide readily reacts with iron to produce ferrous sulfide, this reaction may be utilized to remove the sulfide from waters.

b. The simplest method is to pass the water through a box containing iron turnings. These turnings have to be replenished as the iron is used up in the reaction.

3 . . pH Adjustment

a. Where waters are low in bicarbonates and high in carbon dioxide content, the pH is likely to be in the acid range. Waters containing acid mine wastes likewise have a low pH and are highly corrosive.

b. The pH can be adjusted upward by passage of the water through a bed of limestone rock or by adding either lime or soda ash by chemical feeders.

4 . . Stability Adjustment

a. In order to understand stability adjustment, it is necessary to know something of the action of natural waters with respect to their ability to either corrode metals or to lay down a scale.

b. This pipe scaling-corrosive ability is an equilibrium which depends on several factors and which may be reversed in either direction by adjustment of one or more of these factors. When the water neither corrodes nor lays down a scale it is said to be stable, or in balance.

(1) The mechanism of this equilibrium may be explained in terms of the saturation index, which is defined as the algebraic difference between the actual pH of the water and pH_s, where pH_s is the pH the water would have if, without change in composition, it were in equilibrium with solid calcium carbonate.

(2) The saturation index, which is a measure of the stability of the water depends on these factors: pH, temperature, and concentration of carbon dioxide, carbonates, bicarbonates, and hydroxides present in the water.

. . . Stability diagrams showing the relation of pH to alkalinity factors are available, in large easily readable reproductions, from the AWWA office. These diagrams can be used for the solution of problems involving the stability of water based on equilibrium conditions.

. . . The saturation index can be calculated from the pH and the chemical analysis of the salts dissolved in the water.

c. Another method of determining this reversible scaling-corroding ability of water is the Marble Test.

(1) The Marble Test depends on bringing the water sample into equilibrium with calcium carbonate by allowing intimate contact of the water with pure calcium carbonate, in a closed vessel.

. . . The resulting change in total alkalinity indicates the capacity of the water either to deposit or dissolve calcium carbonate.

. . . The test can also be used to determine the pH which the water will have at equilibrium.

(2) Chas. P. Hoover—*Jour. AWWA*, 30: 1902(1938)—proposed the following technique for the Marble Test:

. . . Determine either alkalinity or pH of the water, or both.

. . . To another portion of the water, add chemically pure washed precipitated $CaCO_3$ in excess (a teaspoonful to 150 ml). Stir a few minutes, allow to settle and filter.

. . . Determine the alkalinity or pH on the treated sample.

—If the alkalinity or pH has increased, the original water was not saturated and will tend to be corrosive.

—If alkalinity or pH are unchanged the water is in chemical balance with respect to calcium carbonate.

—If alkalinity or pH has decreased, the water is supersaturated with $CaCO_3$ and will tend to form scale.

(3) Enslow—*Wat. Wks. & Sew.*, 86:107(1939)—proposed a continuous stability indicator for applying the marble test under plant conditions. The principle of the device is shown in Fig. 6 and it may be constructed from laboratory glassware or purchased from a supply house (Fig. 7).

d. The object of stability adjustment is to create a condition whereby there will be no tendency of the water to form scale or corrode the pipes.

(1) Generally, the adjustment employs pH adjustment either by passage of the water over limestone or by adding lime or soda ash as indicated in Sect. J-3-b.

(2) Practically, stability adjustment is carried on to the extent that a thin coating of carbonate scale is produced as described in the next section.

5 . . Deposition of Films

a. *Calcium Carbonate Film*—Upward adjustment of pH has, as its object, to produce a pH above the calcium carbonate saturation value so that the entire pipe interior will be coated with a thin film of calcium carbonate or carbonate and iron rust mixture.

(1) The theory is that such a coating minimizes the access of oxygen to the cathode areas of the pipe.

(2) The method seems to work better in hard, alkaline waters, where there is a slight calcium carbonate excess. In soft waters, even with a positive saturation index, the calcium carbonate content may be too small to lay down an adequate coating.

(3) The treatment consists of adding either lime or soda ash, or both.

. . . For waters having a negative saturation index (tendency to corrode) lime is used for treatment when the alkalinity is less than 35 ppm.

. . . When the alkalinity of the water is greater than 35 ppm, either lime or soda ash may be used.

. . . Soft waters may need both lime and soda ash to provide both calcium and carbonate. For example, if the CO_2 content of the water is less than 5 ppm and the alkalinity content is less than 10 ppm, both lime and soda ash are added to supply both calcium and carbonate ions and to produce a final alkalinity of about 35 ppm.

. . . The relative amounts of lime and soda ash to be added are determined by trial and error using the results of the Marble Test.

b. *Silicate Films.*—The addition of soluble silicates, such as sodium silicate, in sufficient amounts will produce a precipitated film of calcium silicate, which protects the metal.

(1) Silicate films are found advantageous in naturally soft waters and in waters softened by cation-exchange.

(2) Naturally occurring silicates in water are not as effective for film formation as are added silicates.

(3) The amount of silicate dosage is relatively low, approximately 8 ppm as SiO_2. The 38 per cent commercial solution of Na_2SiO_3 is commonly used for the treatment.

c. *Polyphosphate Films.*—The complex glassy sodium phosphates—(sodium hexametaphosphate, $(NaPO_3)_6$; sodium heptaphosphate, $Na_2O(NaPO_3)_7$; or tetra-sodium pyrophosphate, Na_4PO_7—are used in small dosages to produce an extremely thin film (a few molecules thick) and thereby reduce corrosion attack on iron.

(1) The dosage is approximately 2 ppm.

(2) Some controversy exists as to the actual formation of the polyphosphate film on the pipe interior, but certain observations have been made about the treatment:

. . . In starting the polyphosphate treatment on an old heavily encrusted pipe line system, difficulty has sometimes been noted in the tendency of the polyphosphates to strip off old deposits and disperse them in the water.

. . . Polyphosphates exhibit a sequestering action and prevent the precipitation of iron already in the water or iron dissolved by the corrosive action of the water.

. . . The formation of large tubercles in the inside of the pipe is prevented.

. . . In small water piping in buildings, corrosion products do not collect and clog the piping.

(3) The two best known commercial brands of these glassy polyphosphates are Nalco-18 and Calgon.

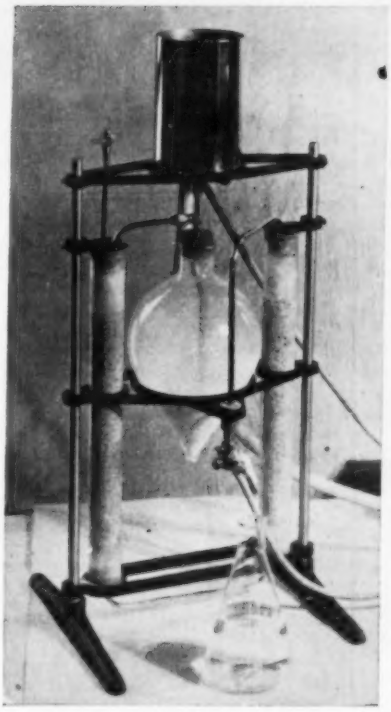


Fig. 7.—ENSLOW continuous corrosion and stability indicator.

K . . . Cathodic Protection

1 . . Fundamentals

a. According to Sudrabin—*Wat. Wks. & Sew.*, 92: 11, (1945)—cathodic protection in the simplest sense,

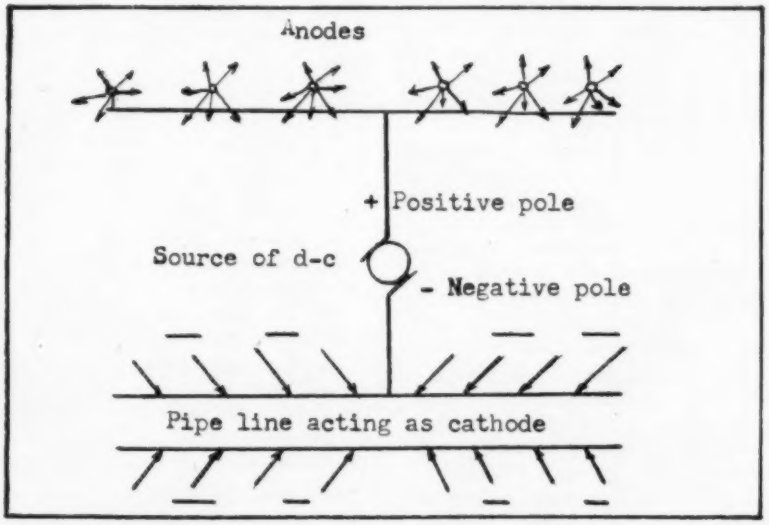
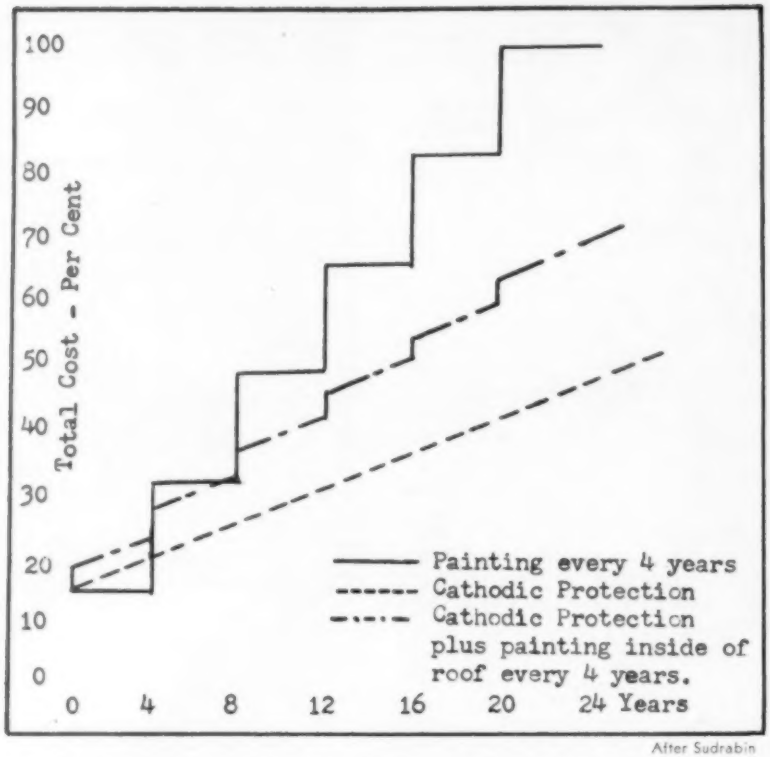


Fig. 8.—ELECTRICAL circuit for cathodic protection.



After Sudrabin

Fig. 9.—COMPARISON of overall costs of cathodic protection vs. painting of interior tank surfaces during 24-yr period.

"consists of stifling the flow of current which accompanies electrochemical corrosion, by projecting a current flow through the corroding medium to the metal surface to be protected."

(1) Stated another way, the electrochemical reaction of corrosion can be reversed and corrosion prevented by rendering the metal surface "passive" by applying a direct current overvoltage to the surface to be protected and thus making this surface cathodic instead of anodic.

(2) By this impressed electrical current, electrons are fed into the metal, instead of the reverse action of corrosion. This system is diagrammed in Fig. 8.

b. Another method of obtaining protection of cathodic nature is to attach a metal of higher oxidation potential, which being anodic, will corrode and will be sacrificed to prevent the corrosion of the principal metal.

(1) This system is more correctly termed "galvanic protection", rather than cathodic protection.

(2) An example of this type of corrosion prevention is the attachment of zinc plates to steel surfaces. —Galvanized iron pipe is also an example of this "galvanic protection".

c. The order of magnitude of this impressed electric current is from 1 to 15 milliamperes.

(1) Voltage depends on resistance of the circuit and may range from 1½ to 30 volts.

(2) Only direct current may be used.

2 . . ADVANTAGES AND DISADVANTAGES

a. Sudrabin lists these advantages for cathodic protection:

(1) Installations often can be made without taking the equipment out of service and this is especially advantageous for elevated steel storage tanks.

(2) Surfaces to be protected do not require special preparation.

(3) The use of adequate current density will give adequate and continuous, uninterrupted and non-failing protective effect.

(4) Cathodic protection requires little maintenance and little supervisory attention.

(5) The chemical nature of the bulk of the water is unchanged.

(6) The impressment of electrical current will cause the precipitation of a thin film of calcium carbonate on the metal surface and this is added protection.

b. Generally there are only two disadvantages to cathodic protection.

(1) Since the anode cannot be installed inside a water main, the system is of no value for protecting the internal surfaces of pipe lines. It can be used, however, to protect the outside surfaces of pipe lines.

(2) Ice presents a problem to the handling of the anode in the inside of elevated tanks in northern climates.

3 . .SOURCES OF PROTECTIVE CURRENT

a. Excluding the galvanic type of protection, the most used method of obtaining the protective current is an external potential force that can be regulated to impress the current necessary for protection.

b. This external potential can be supplied as direct current from storage batteries, wet type rectifiers, dry type rectifiers, and direct current generators driven by electric motor, gas engine, or windmill.

4 . . Economics

a. It has been stated that cathodic protection will compete on an economic basis with other methods of corrosion prevention.

b. For elevated water tanks, data have been prepared to show that cathodic protection is less expensive over a 24 year period than maintenance and regular painting (See Fig. 9).

c. Cathodic protection has the added advantage that it is continuous whereas between intervals of painting, the paint surfaces may fail in many areas, thereby allowing corrosion to proceed at those points.

References

Among the reference works consulted for the material in this lecture are the following texts:

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Buswell—"Chemistry of Water and Sewage Treatment" Chap. 9, (Chemical Cat, Co., New York City)

Fair and Geyer—"Water Supply and Waste Water Disposal", Chap. 23. (John Wiley and Sons, New York City)

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Romanoff—"Underground Corrosion", Nat. Bur. of Stds. Circular 579 (Govt. Print. Office, Washington, D.C.)

Speller Corrosion: "Causes and Prevention", 3rd Ed., (McGraw Hill Book Co., New York City)

Steel—"Water Supply & Sewage", 3rd Ed. Chap. 5 (McGraw-Hill Book Co., New York City).

Uhlig—"Corrosion Handbook", (John Wiley & Sons, New York City.)

Next Lecture—Water Softening

Shock Pressure from Water Hammer

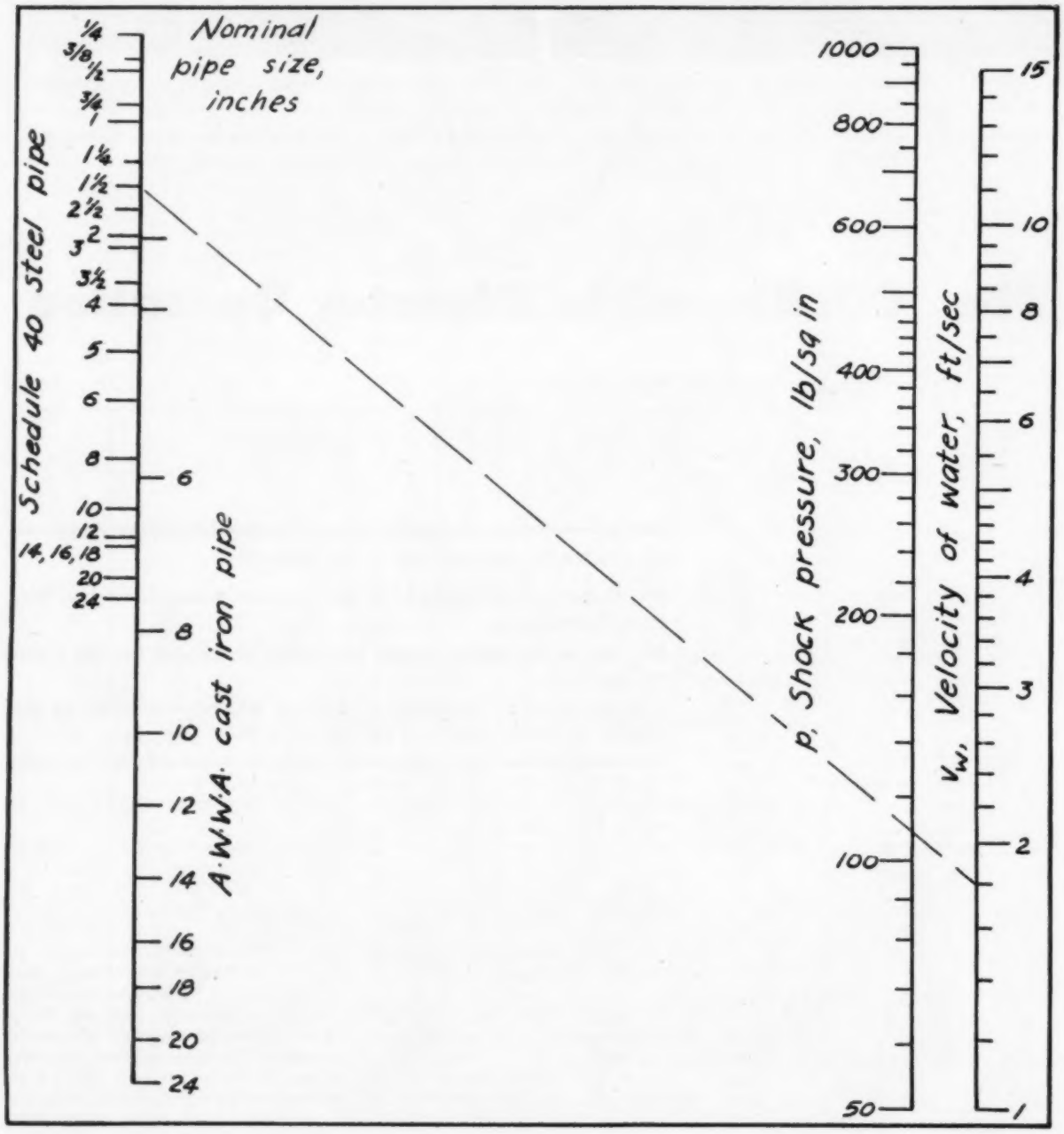
A Nomograph
by D. S. DAVIS
Professor of Engineering
University of Alabama
Tuscaloosa, Ala.

DATA[1] that deal with V_p, velocity of pressure wave in feet per second; V_w, velocity of water in feet per second; and p shock pressure in pounds per square inch for instantaneous closure of valves in water lines can be correlated by means of the expression.

$$p = 0.01369\ Vw\ (Vp - 76.6)$$

This equation can be solved readily and accurately through use of the accompanying nomograph on which V_p has been replaced by the nominal pipe size in inches for both Schedule 40 steel pipe and AWWA cast iron pipe. (Note that for steel pipe, the graduation for 2-inch pipe appears between that for 2½ and 2-inch pipe. This situation does not represent an error; the scaling depends upon the ratio of internal diameter to thickness of wall and is exact agreement with accepted dimensions.

The use of the chart, which was constructed in accordance with well-known methods[2], is illustrated as follows: What shock pressure should result when a valve is suddenly closed in a 1½ inch steel pipe through which water is flowing at 1.8 feet per second? Connect 1½ on the left side of the nominal pipe size scale and 1.8 on the V_w-scale with a straight line and note the intersection with the p-scale at 110 pounds per square inch.



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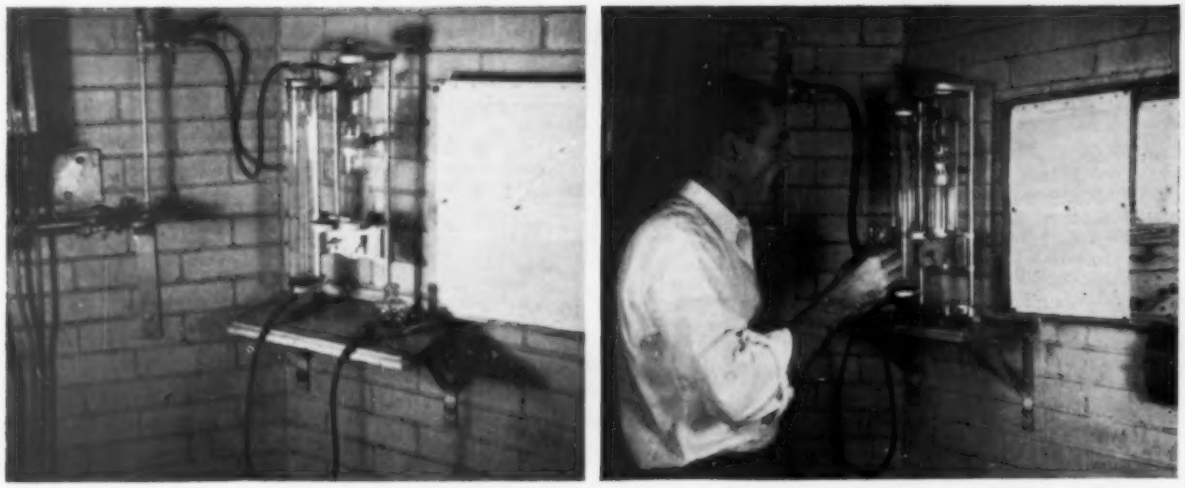
2. Davis, D. S., "Nomography and Empirical Equations," Chapter 6, New York, Reinhold Publishing Corporation, 1955.



CO_2 GAS ANALYZER permanently located in the digestor building near the manometers on gas lines from individual digestors

On left the rapid test for CO_2 content of digestor gas is being made for entry on the day-to-day record chart alongside.

The "CO_2 Alarm" in Digestor Operation

"As Goes the Digestor, so Goes Your Plant!"

by FRANK H. MILLER and W. T. BARRON

Mr. Miller is chief engineer of the Hampton Roads Sanitation District Commission

Mr. Barron is superintendent of sewage treatment for the Commission.

In this article is revealed a practical means of maintaining the health of sludge digestors by watching their "Co_2 Line."

THE HAMPTON ROADS Sanitation District Commission, serving Norfolk, Virginia, and its environs, operates three primary sewage treatment plants with separate sludge digestion and chlorination.

The Lamberts Point Plant serves the southern portion of Norfolk, South Norfolk and portions of Norfolk and Princess Anne Counties. It has a capacity of 22 mg with four digestors of 75,000 cu. ft. capacity each, with floating covers.

The Army Base Treatment Plant serves the northern portion of Norfolk and the Norfolk Naval Base, Air Station and Supply Depot, which make up the largest naval shore installation in the world. It has a capacity of 11 mg with two floating cover digestors of 114,000 cu. ft. each.

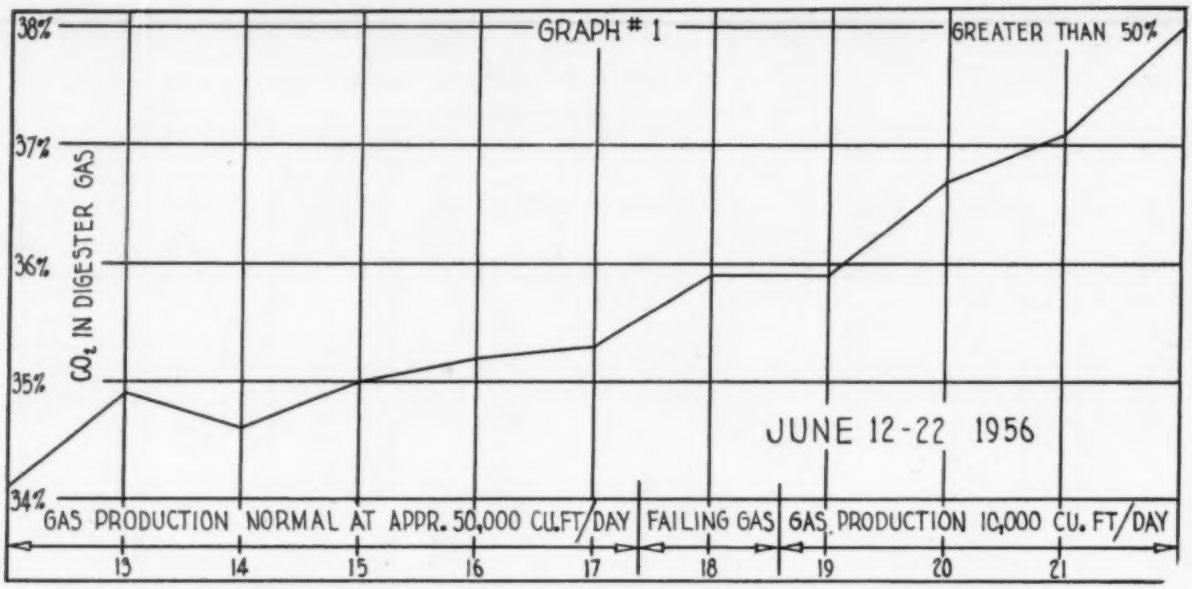
The Boat Harbor Treatment Plant at Newport News (see cover picture) serves that city, the cities of Warwick and Hampton, and the Army Continental Command Area at Fort Monroe. It has a capacity of 12 mg with two digestors of 75,000 cu. ft. capacity each, one with a floating cover and the other with a fixed concrete cover.

At the Lamberts Point Plant and the Boat Harbor Plant periodic trouble with sudden failure of the digestion process has been experienced. These failures were studied and found to be caused by three factors.

Factor #1—Raw sludge load beyond the capacity of the existing digestion tanks.

Factor #2—Scum buildup in the digestors that resisted all efforts to effect dispersion. (Filter tip cigarettes, among other things, are no help!)

Factor #3—This factor is related to the scum buildup. The H.R.S.D.C. has external heat exchangers for sludge heating in two of their plants and submerged heating coils in the other. The scum buildup seems to restrict the proper dispersion of heat throughout the tanks. On several occasions temperature samples have been taken throughout the entire depth of the tank to find that the upper 10 feet in the tank had a temperature of less than 60°F, while the next lower 12 feet had a temperature



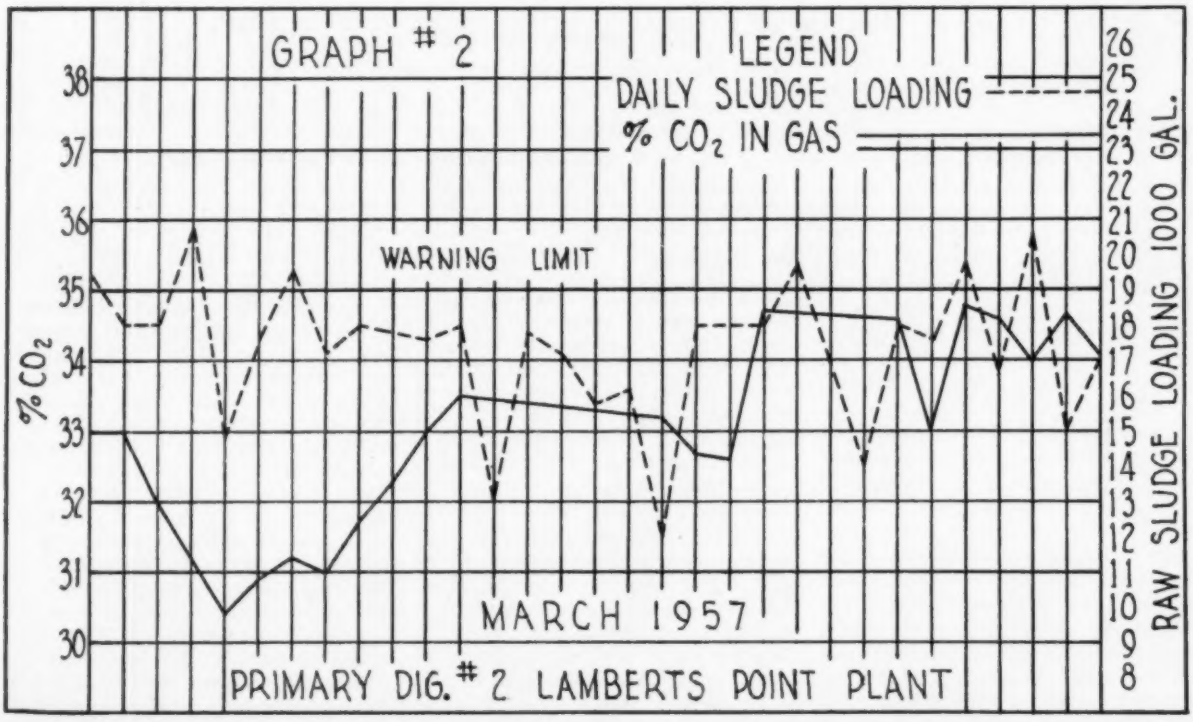
GRAPH #1—Reproduction of a ten day portion of CO_2 record chart at the Boat Harbor Plant

Note the three days of persistant CO_2 increase, June 19-22, the fore-warner of trouble and digester failure that followed.

of over 90°F. This condition was was much more pronounced in the tanks heated with the external heat exchangers than in the tanks with submerged hot water heating coils; however, loading is much less in the latter. Singly or in combination, these factors contribute to making the digestion process a critical operation that must be watched closely at all times.

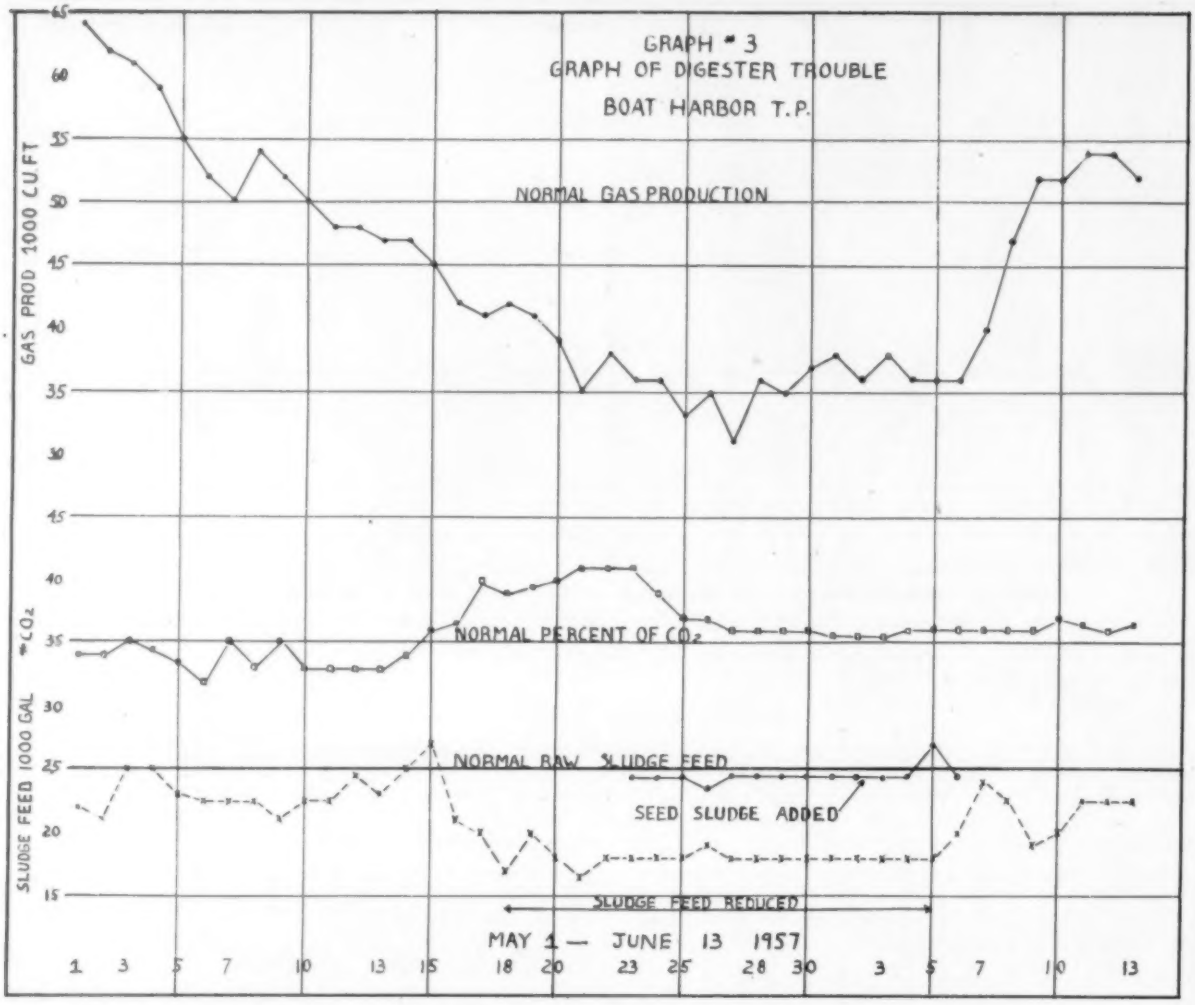
Experience a "Dear Teacher"

By bitter and costly experience we learned that when a digestion tank has failed, it has never been possible to bring it back to normal operation again when there is no standby digestor capacity to which can be diverted a portion of the daily heavy load of raw sludge. In our case we had no choice but to pump the sludge into the "sick" digestors or shut down the plant. The plants are in such close proximity to oyster beds and bathing beaches that any interruption in the treatment process is highly undesir-



GRAPH #2—Reproduction of a 30 day CO_2 record chart for No 2. Digestor functioning normally at the Lamberts Point Plant.

Note the relationship between the digestor loading (dashed line) and the fluctuating CO_2 content (solid line), but never exceeding the 35% line for more than one day at a time.



GRAPH #3—Chart for month of May 1957 and first part of June at the Boat Harbor Plant.

Note the warning signal of persistant increase of CO_2 content beginning May 13th and climbing to 41%. The remedy consisted of reduction of digestor loading and resultant reduction of CO_2 in gas to the 36% level.

able. It was also learned that a "sick" digestor could not be remedied by the daily addition of seed sludge hauled by tank trucks. In one instance good seed sludge was hauled by tank truck and applied at the rate of 30,000 gallons per 24 hours for a period of one week. At the end of this period there was no laboratory evidence or any other improvement in the digestor. It is felt that in the battle of the sick digestor, as in war, no matter how large the army, if too few soldiers are put in the field at one time they will be defeated by the enemy. We proved this point by filling our elutriation tanks (110,000 gallons capacity) with good seed sludge, withdrawing 110,000 gallons of sour sludge from the "ailing" digestor and replacing it by rapidly pumping in the seed sludge. As a result the digestor returned to normal operation.

We Search for a Warning Signal

Our interest became critical in some practical method that could be used to indicate impending digestor trouble before it is too late. We were sure that by the time a significent pH change takes place in the digestor liquor the sludge has lost its buffering power and is "sick". Using the test for volatile acids, it was found that a normal operating digestor had a volatile acids content of from 85 to 250 ppm. Samples from the scum laver would run a volatile acids content of from 1,000 to 2,000 ppm. To our sorrow it was found that a digestor could have a 250 ppm volatile acids content and forty-eight hours later have a volatile acids content of over 1,000 ppm with an accompanying gas production drop of 60%.

The small quantity of gas still being produced after failure in this instance showed a CO_2 content of between 50% and 60%. A daily CO_2 content check on the gas from this digestor was made. As the digestor was coaxed back into operation it was observed that the CO_2 content gradually dropped. Over a period of a month the CO_2 content dropped from a high of 60% to a daily average of 33%. When this daily average of 33% was re-established the digestor was back in normal operation, producing a quantity of gas in proper relation to the daily raw sludge feed.

Our records indicate that a digestor in normal operation will produce a gas with from 31% to 35% CO_2 content. Of course if lime is being fed to a digestor on a routine basis the CO_2 content will be lower. Any plant that feeds lime to its digestor as a routine procedure will have to establish what the normal CO_2 con-

tent of its gas should be. Our records indicate that when the CO_2 content of the gas builds up to between 36% and 37% trouble will soon follow. On days of exceptionally heavy raw sludge loads the CO_2 content of the gas will go above 35% temporarily, but usually drops back below 35% when the load is reduced. A sudden jump of CO_2 on a daily check can be expected if any abnormal conditions exist.

What to watch for is that presistent upward trend in CO_2 content for three or more days. This is the key to controlling a digestor by daily recording the CO_2 content of the gas. We set up a graph in the digestor control room with a horizonal red line drawn at 35%. The CO_2 content of the gas from each digestor is determined daily at the same time of day and plotted on this graph. Any CO_2 reading of 35% or over on consecutive days is watched very carefully. If the CO_2 increase trend continues the raw sludge load is shifted to another digestor if possible, or may even be tank trucked to another plant. The scum and heat situation is also checked. In our opinion the trend of rising CO_2 in digestor sludge gas is the best early warning indication of impending digestor trouble of any control measure now available, no matter what the cause. This trend can usually be recognized in time to circumvent further trouble. Presented herein are three graphs, two of which represent a portion of the actual plant control graph.

Graph #1 shows percent CO_2 during a trouble period, demonstrating the rising CO_2 which was not reflected by either volatile acids in the sludge or total gas produced.

Graph #2 shows CO_2 results in the normally operating digestor. Note the relatively smooth CO_2 curve obtained.

Graph #3 records Raw Sludge Feed, Seed Sludge Added, Percent CO_2 and total Gas Production in a composite graph for a recent period of perilously imminent digestor failure. In this case, a failing gas production and the CO_2 rise in the gas occurred at about the same time. Perhaps neither alone, and most certainly not the gas production record alone, would have been entirely convincing of the imminence of trouble. Together, their early warning resulted in remedial action and in all probability avoided a much more serious condition than that which did occur. It is to be noted that the CO_2 increase warning began on May 14th and the gradual but presistent rise in CO_2 content for three successive days was a clear warning of trouble ahead unless corrective measures were applied. In this instance the remedy was a reduction in digestor loading, followed by the addition of digested sludge to re-establish a higher ratio of digested sludge to raw sludge input.

In each of our three treatment plants we have installed a standard Orsat type stack gas analysis unit with the burette and the single CO_2 absorption unit only. This equipment cost approximately $130.00 but less expensive gas analyzers for the simple CO_2 determination are available. The absorption unit is charged with 180 ml of 9-N. NaOH, which is replaced when it becomes very milky due to sodium carbonate precipitation. Tests are made daily at the same hour each day on all primary digestors by the regular operating personnel. The picture at the head of this article shows the CO_2 Analyzer and E. K. Goffigon, our chemist, making a CO_2 test. Note the record graphs, alongside, to which is added the CO_2 content of the day.

Conclusions

By the time a significant change has occurred in pH value in a digestor, it is usually too late to save a heavily loaded tank.

Volatile acids content in a digestor cannot be determined in any practicable manner with sufficient accuracy and in time to permit needed adjustments which might avoid digestor failure.

The rise of CO_2 content in digestor gas above the established normal is the best early warning signal of failure yet discovered and usually becomes evident in time to take corrective measures.

The gas analysis check can be made quickly and easily by an operator, with a minimum of special instruction. The services of a chemist are not required to make this daily routine check.

In making CO_2 determinations:

(a)—Place the gas analyzer near the digestor gas line in a permanent place. Do not attempt to move it about the plant (equipment is fragile and expensive breakage will otherwise be high).

(b)—Do not use composited gas from more than one digestor at a time for testing. Results will be misleading and need will not be served.

(c)—Purge gas line thoroughly with digestor gas before drawing gas into testing equipment.

(d)—A convenient point for sampling is usually the centrally located manometer tubes for all digestors. From here gas can be conveyed readily by rubber or plastic tubing to apparatus located nearby.

McCartt New Supt. Covington Sewage Treatment Plant

W. D. Anderson, Gen. Mgr. of Sanitation District No. 1, Covington, Ky. announces that Lawrence E. McCartt has been appointed Superintendent of the District's Sewage Works, succeeding Thomas S. Danks, retired.

Mr. McCartt was graduated from the University of Cincinnati with a degree in Civil Engineering. He served for a number of years as City Engineer for Covington, Kentucky. For the past 15 years he has been County Engineer for the County of Kenton, Kentucky. For the past 12 years Mr. McCartt has been a member of the Board of Registration for Engineers for the Commonwealth of Kentucky.

"Happens every time we start a new job on a Friday."

Abel Wolman Again Honored

Receives Honorary Degree from Drexel Institute

On June 15, 1957 Dr. Abel Wolman of Baltimore, Md., was honored by Drexel Institute of Technology, Philadelphia, Pa., which conferred on him the honorary degree Doctor of Science.

The citation reads "To Abel Wolman, eminent consulting engineer, distinguished teacher and honored public servant who, through brilliant leadership and accomplishment, has created new horizons for the engineering profession."

Dr. Wolman was presented by Francis S. Friel, as a friend and as Vice Chairman of the Board of Trustees of Drexel Institute.

New Parshall Flume Type

Sewage Flow Measuring Unit

Eliminates stilling chamber, debris accumulation, some maintenance and considerable cost

by EDWARD T. DAVIS

Mr. Davis is a partner in the Chester Engineers, of Pittsburgh, Penna. In this article he describes the first installation of a new flow measuring device, as the outgrowth of his ideas and specifications.

AS CONSULTANTS, we of the Chester Engineers have long been dissatisfied with available methods for the measurement of sewage flow. In servicing clients in the sewage fields, it was found that most flow measurement devices were lacking in desired accuracy or usually required both cumbersome and expensive installation procedures and frequent maintenance.

An Idea Is Born

About two years ago these shortcomings were discussed with a representative of Penn Instruments Division, Burgess-Manning Company. That conversation proved to be the initiation of an extensive research development and testing program at Burgess-Manning's Philadelphia plant. The result was a vastly improved Parshall flume unit which not only measures sewage flow with much greater accuracy, but also requires little or no maintenance and markedly saves on construction costs as well.

The State School at Polk, Pa. (a client of the author's firm) beginning in December 1956, provided the scene for the initial use of the new unit. In addition, it was placed on display at the Manufacturers' exhibit in connection with the Los Angeles (1956) annual meeting of the Federation of Sewage and Industrial Wastes Associations. First results at the Polk School and the reactions of engineers at the Los Angeles meeting proved to be highly satisfactory and gratifying. As a consequence, the Penn Instruments Division is moving ahead with plans for mass production of the new unit, which has been designated Type ML.

NEW Burgess-Manning Type ML Parshall flume unit, showing 4-inch steel float riding on water surface.
This allows rubbish, debris, etc., to ride through flume without becoming engaged with the float. Use of this unit eliminates necessity of stilling chamber, piping, fittings, concrete drywell, or water backfeed connections.

Polk School Installation

The Polk School provided an appropriate testing ground for the new unit. The school is an institution housing approximately 3,400 mentally defective children, plus a medical and maintenance staff numbering 1,000. The school operates a central power plant for the manufacture of its own light, heat and power. It uses about 16,000 tons of coal yearly to heat approximately 10,000,000 cubic feet of building space. With the preparation of meals for the school's large population, the operation of a laundry servicing both patients and staff, and the round-the-clock use of toilet appurtenances by the patients,

sewage facilities are in almost constant use.

The ML unit was particularly welcomed by the school maintenance staff because of the new disposal plant recently constructed so that the school can handle its own sewage problems. Lloyd McKissick, school maintenance engineer, reported that the new unit "worked perfectly" in all performances and was in keeping with the school's modern plant design. The writer was particularly gratified because the new unit ended a long period of trial and error in searching for adequate methods of sewage flow measurement.

Prior Methods

Years ago, Venturi meters were employed; but frequent stoppages occurred because of solids in the sewage. It was necessary to place the transmitting and recording mechanisms in a gravity flow line.

Later, an endeavor was made to measure flow into the sewage disposal plant by gravity through the use of weirs and orifices. But again the same type of defects resulted. Solids collected back of the weirs and orifice plates or the range of flow was limited or complicated.

In every case, measuring devices such as floats set to the side in wells for accurate readings required continuous maintenance because they were always plugging up and consequently not recording accurately.

Still later, Venturi flumes were used, but with the necessity of separate wells for recording the height of water, trouble was always experienced.

One of the first methods used to measure the depth of flow in Venturi flumes was by means of a low-range pressure recording gage reading from 0 to 1 foot or 0 to 2 foot. The pressure bulbs still had to be placed in wells to protect them; therefore, the same maintenance problems arose.

Venturi flumes were then discarded in favor of Parshall flumes, the capacity of which could be more readily calculated and which were more accurate than the Venturi flumes.

For years a search was made for a method of recording the depth of flow in the upstream part of the flume, where it would be unnecessary to use separate float wells. The development of the improved flow measuring unit answered this need. Its accurate measurement capabilities and its small maintenance requirement have solved the thorny problem of measuring liquids which contain solids.

Of the three main benefits of the

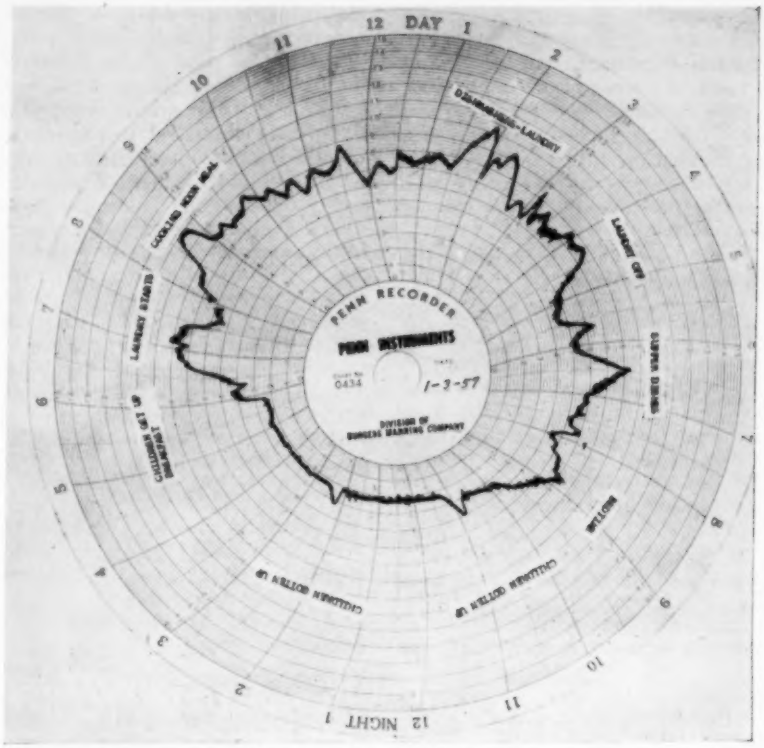
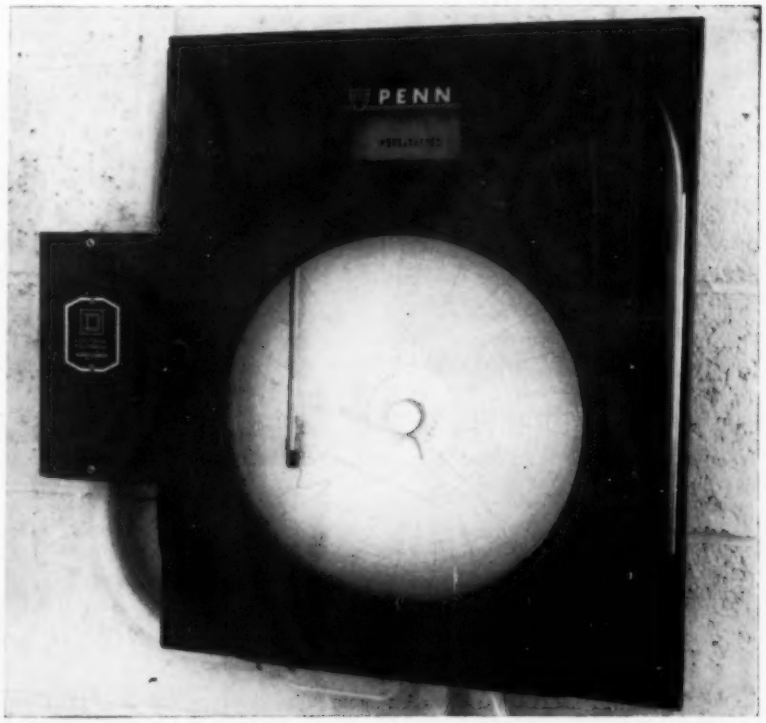


CHART of sewage flow for one day at Polk, Pa. State School, where first installation of new Type ML Parshall flume unit was made.



SEWAGE flow is recorded in 12-inch diameter, uniformly graduated chart designed for daily or weekly removal.

Totalizer (at top) is of cyclometer type. Receiver housed in pressed, dust and moisture-proof case can be installed anywhere up to 3,500 feet from flume.

new measurement unit—increased accuracy, construction economies, low maintenance requirement—the last is perhaps the most welcome because of the frequent, bothersome, and dirty task of sludge-cleaning which the old float or stilling well required. The unique construction of the new unit accounts for the small amount of maintenance necessary.

How the Unit Works

The salient features of the unit are a 4-inch steel float, a float rod, and a core-and-coil transmitting device mounted in a waterproof metal case attached to the side of the flume or suspended from or attached to a cross piece at the entrance of the flume. The float rides on the surface of the water, being immersed only ½ inch. Consequently, seven-eighths of the float is completely out of the water and any rubbish, debris, etc., can ride through the flume without becoming engaged with the float itself. There is no need to clean out a float well, there are no pipes to become clogged, and the recording instrument itself is completely weatherproof. In addition, all exposed parts are made of stainless steel or (as in the case of the structure containing the core and coil) of cast iron properly painted to be impervous to weather conditions.

Because the need for the construction of float pipes, stilling wells, connecting lines, valves, backflushing device, etc., is eliminated, it is estimated that the installation of the new type unit results in savings of approximately 35 percent. This might mean several hundred or several thousand dollars, depending on the particular case. The installation itself is relatively simple and quickly accomplished. After completion of construction of the ML flume, which requires a shallower concrete pit dug below the surface than do the old types, only a day's time is needed for the installation of the recording meter.

Continuous Transmission

The meter can be installed anywhere up to 3,500 feet from the flume. Transmission is continuous, of the null balance inductance bridge type, necessitating just three twisted insulated and shielded wires to the receiver. Power is necessary at the receiver end only.

Each receiving instrument indicates flow on a uniformly graduated flow scale separate from the pen arm and having a length of at least 10 inches. The flow is recorded on a 12-inch diameter uniformly graduated chart designed for daily or weekly removal. The totalizer is of the cyclometer type, having at least seven digits and requiring only the use of zeros for multiplying factors. The receiver is housed in a pressed dust and moisture-proof case.

The receiver includes a two-phase servo motor for positioning the pointer, pen arm and totalizer with high and equal power over the entire scale range. Positioning of the servo motor is accomplished by the use of an electronic amplifier utilizing standard electron tubes with full-scale pen travel within 9 seconds. The entire receiver mechanism is mounted on a pivoted frame to permit inspection of all parts without the need for interrupting operation.

The Type ML meter is equally adaptable for measurement of flows across weirs or through open flow nozzles and is designed to be applicable to virtually every kind of sewage problem.

Officials of Burgess-Manning's Penn Instruments Division advise that the new ML meter will be mass produced as a stock item, with the transmitter and float mechanism custom made to suit the established dimensions of Parshall flumes.

"Bill" Sherwood Passes

Connected with Hersey Co. for 56 years.

William C. Sherwood, retired secretary of the Hersey Manufacturing Co., South Boston, Mass., died on June 9. He was 78 years old and lived at 88 Pine Ridge Road, Waban, Mass.

A man of great integrity and outgoing personality, "Bill" Sherwood was a native of Jersey City, N. J., where he formerly served on the N.J. Civil Service Commission. He had been associated with the Hersey Company for 56 years when retiring only last year.

Mr. Sherwood was a past-president of the Water & Sewage Works Manufacturers Association (1946). He had also served on the Board of Directors of the New England Export Club of Boston for 6 years (1949-1955).

He was a member of the American Water Works Association, the Engineers Club of N.Y. City, Boston Madison Square Garden Club, Pan American Society of Boston, Inter-American Association of Sanitary Engineers, American Ordnance Association, National Association of Corrosion Engineers. He was a life member of the Society for Preservation of New England Antiquities.

He is survived by his wife, Iola Boulter Sherwood.

Things You Can Not Do!

"You can not bring about prosperity by discouraging thrift. And, you you can not help the wage earner by pulling down the wage payer."—*Abraham Lincoln*

Water Works Men Commended for Stand on Fluoridation

The American Public Health Association during its annual convention, passed a resolution commending the American Water Works Association for its *"leadership and farsightedness"* in its policy statements on fluoridation of public water supplies.

The text of the resolution follows:

WHEREAS; fluoridation of public water supplies is a recognized procedure for the prevention of dental decay and thus an aid in improving child health, and

WHEREAS; such protection extends to adult life of individuals who drink fluoridated water during childhood, and

WHEREAS; the American Water Works Association has demonstrated its leadership to sound public health practice by recognizing the propriety of water works officials in adding fluorides to their water supplies under controlled conditions, now therefore be and it is

RESOLVED; that the American Public Health Association record its appreciation, commendation, and recognition of the leadership and farsightedness of the American Water Works Association in providing to its membership sound guidance

SEWAGE WORKS PRACTICES

"Package" Sewage Treatment Plants

The eighth of a series of articles

by THEODORE JAFFE

Mr. Jaffe is Professor of Civil Engineering at Alabama Polytechnic Institute, Auburn, Ala. In this series for the practical sewage treatment plant operator, he discusses matters of interest often overlooked in the press of routine duties.

THE TERM "PACKAGE" as applied to sewage treatment plants usually means a compact, relatively simple to operate unit designed to give complete treatment to the wastes from a small community. These package plants are generally installed where a high degree of B.O.D. removal is required, yet other factors prohibit the use of conventional types of secondary treatment. Some of the factors are small populations, built-up areas, lack of trained operators, limited funds, or isolated locations such as housing developments and institutions. Units of this type are often used also for industrial waste treatment.

Although these package plants are usually custom designed by the equipment manufacturer and may differ in the scheme of treatment all utilize the activated sludge process to effect the high degree of removal to be accomplished. It may surprise some operators to learn that a plant used in situations such as described above, would use activated sludge. The common idea of such a plant is that of a complex installation requiring skilled and constant operation. While this is true for conventional activated

Photo Courtesy Yeomans Bros.

Fig. 1—"CAVITATOR" at New Holstein, Wis.

Photo Courtesy Infilco, Inc.

Fig. 2—"AERO-ACCELATOR" at Saint Die, Voges, France.

sludge plants, it is not true for these package plants. What then, is the difference?

Fundamentals of Package Plants

The heart of these unitized treatment facilities is the use of mechanical aeration instead of diffused air. In a previous article of this series[1], the differences between these two aeration systems were discussed. Briefly, in mechanical aeration air is supplied to the sewage-activated sludge mixture in one of two ways: either by some form of air disperser producing fine bubbles right in the mixture, or by allowing the mixture to flow in a thin sheet so that the oxygen from the atmosphere is directly incorporated.

Several other changes from conventional activated sludge practices are employed in package plants. All of these are not found in each type of package, since the manufacturers have different theories as to the most efficient design of the units. One type provides primary and secondary sedimentation and activated sludge treatment all in a single unit, another requires primary sedimentation ahead of the package but combines aeration and secondary sedimentation in the single unit; another type combines primary sedimentation and aeration in the single unit but requires secondary sedimentation.

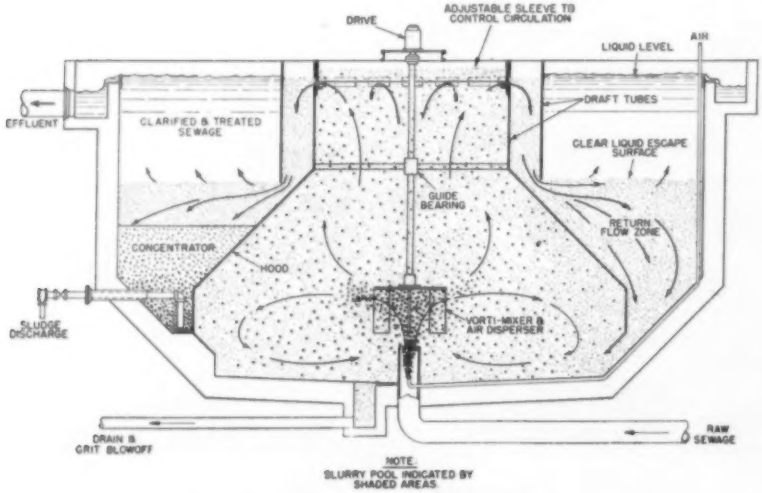


Fig. 3—PRINCIPLE of "Aero-Accelator".

As can be seen, each of these schemes seeks to eliminate as many individual operation units as possible, and replace them with multi-purpose units. This not only tends to reduce the initial cost of sewage treatment, but may also lower the cost of operation and maintenance, and reduce the amount of personnel required. It is a further desire of the designers that by combining units, operation will be simplified and the plant operator's life made easier.

Compressed Air Aerator

To illustrate the various types of package plants available, one of each of these will be discussed in some detail. An example of the disperser type of aeration section is that manufactured by Yeomans Bros. Co. called the "Cavitator" (Fig. 1). Another is that used in the "Aero-Accelator" manufactured by Infilco, Inc. This unit is shown in Fig. 2 and has been described more fully in several articles.[2,3]

The original design of the "Aero-Accelator" called for raw sewage to be treated in the unit and a final effluent, ready for chlorination and discharge, to be produced. Obviously such a unit would effect tremendous savings in initial cost since it would eliminate primary and secondary clarifiers, and having a shorter aeration period, would effect savings here too. Since only a single unit, or multiple single units, are required, maintenance and operation would be simplified.

Recently Infilco has advocated that a thickener-skimmer unit be placed ahead of the "Aero-Accelator" for solids and scum removal, and into which the excess activated sludge is returned for thickening. Total flow through time is 5-6 hours at average flow for a domestic sewage.

The "Aero-Accelator" works in the following manner (Fig. 3): The waste is introduced into the unit below the "Vorti-mix Aerator". Compressed air is also introduced here below the aerator, but above the sewage. Due to the agitation produced by the Vorti-mix, the air is dispersed into fine bubbles which tend to rise to the surface. This up-flow produces a mixing of the sewage, air, and activated floc, and brings the mixture to the surface of the inner tube.

The mixture then flows through variable openings into the draft tube and into the clarification zone. Flowing downward here, a separation of the clarified effluent from the sludge occurs with the effluent rising and leaving the tank over the discharge

weir. The sludge settles, part being returned to meet the incoming sewage, part being wasted through a blow-off device.

Thin-film Aerators

The second general type of aeration device used in package plants is that of a surface or thin-film aerator. These units are sold under various names and are manufactured by Chicago Pump Co., Yeomans Brothers Co., Process Engineers Inc., and others. Figure 4 shows the Chicago Pump Co. Mechanical Aerator, and illustrates the spilling over of the mixed liquor at the surface of the up-flow tube. Figure 5 shows the aeration action in the Yeomans "Hi-Cone Aerator". There are other means of mechanically aerating the sewage.

This type of mechanical aerator is designed to obtain certain results. First, any aeration system must supply as much oxygen to the mixed liquor as possible. Further, it should do this efficiently and economically. It must also insure an intense and intimate mix of the sewage and the activated sludge, yet must not destroy the floc by too intense an action.

Mechanical aerators seek to accomplish these objectives by these means:

(1) Air is compressed, brought into the unit, and broken into fine bubbles by a rapidly revolving rotor as in the first types discussed above, or the mixed liquor is brought into contact with the atmosphere in a thin sheet of liquid to absorb oxygen directly. To assist in incorporating oxygen into the mixed liquor these units cause a turbulence by rotation or by splashing of the liquid.

(2) Mixing also is accomplished in one of two ways. These units are designed for either up or down-flow patterns. The sewage and activated sludge will either rise or fall for the first portion of the aeration period, and reverse itself thereafter for the remainder of the aeration period. Some units rely on propeller type devices to raise the liquid, others on the air bubbles, and some utilize a combination of these two methods. The downward flow is usually left to nature, although some designs assist nature by lifting from the bottom, thus producing a "hollow space" under the upper layers.

The operation of the splash type aerator can be seen in Fig. 4. Settled sewage is brought into the aerator unit at the surface and is drawn down by the circulatory motion in the tank while being mixed with the activated floc. On reaching the bottom, center, it is drawn into the central draft tube and up by a propeller. As it reaches the surface, it is deflected outward and down by a diffuser cone.

Due to the turbulence of this action, air is incorporated and mixed with the liquor. This process continues, thus aerating the sewage and the activated floc. The mixture then passes into a final settling tank for separation of the sludge and the treated effluent. Other manufacturers have different designs of course, but all basically rely on agitation and turbulence of the mixed liquor, in contact with the atmosphere, to supply the oxygen required for the activated sludge process.

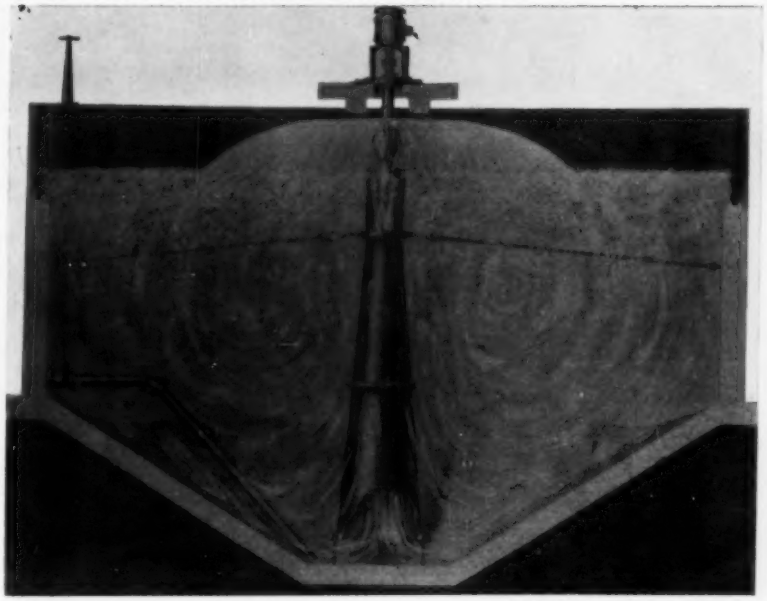


Photo Courtesy Chicago Pump Co.

Fig. 4—MECHANICAL Aerator.

Combination Units

As mentioned previously, mechanical aerators are often combined with sedimentation units, either primary or secondary to accomplish sewage treatment. Necessarily, these combination units are sectionalized although they are a single unit. Such aerator-clarifiers are made by most of the equipment manufacturers under various names such as the "Currie Claraetor", "Aerator-Clarifier", "Aero-Accelator", etc. Again, these may use diffused air, or more likely, mechanical aerators.

Photo Courtesy Yeomans Bros.

Fig. 5—"HI-CONE" Aerator in operation.

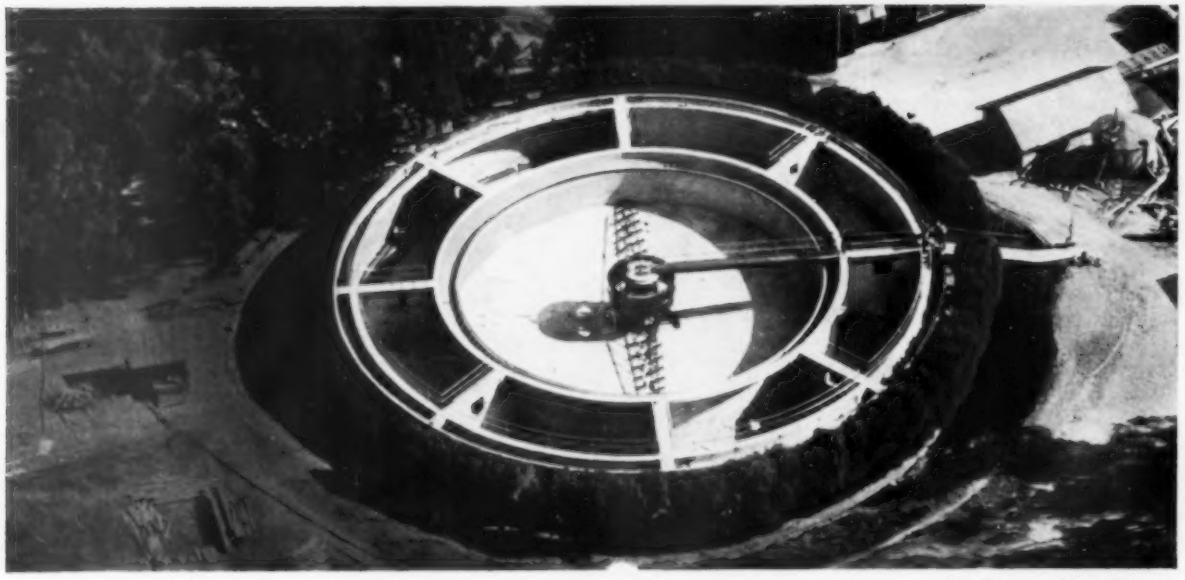


Photo Courtesy of Dorr-Oliver, Inc.

Fig. 6—"CURRIE CLARAETOR" at Tri-City Sewage Treatment Plant, Pasadena, Calif.

Figure 6 shows an aerator-clarifier manufactured by Dorr-Oliver, Inc. Aeration of the sewage and the activated sludge occurs in the outer, circular section and sedimentation takes place in the inner section. Aeration in this unit is supplied by diffused air, or by mechanical means.

A similar unit, made by the Chicago Pump Co., uses their mechanical aerator in combination with a clarifier; it is shown in Fig. 7. Operation is very similar to that described previously.

Sludge Wasting

In addition to compactness, all of these package plants have attempted to simplify operation, so as to reduce the personnel required, when compared with a conventional activated sludge plant. For example, in all types of activated sludge more sludge is produced than required for operation. It is necessary therefore, to waste some while returning the rest. To simplify this procedure, all package plants incorporate some mechanical means of accomplishing this. In the "Aero-Accelator" the sludge is concentrated in a hopper along one sector of the tank and the amount to be wasted is controlled on a time-cycle arrangement that opens and closes a valve automatically. In the Chicago Pump Co. "Aerator-Clarifier", an adjustable weir arrangement is provided to split the return and the excess sludge flow as the operator desires. Other units have similar devices.

Further claims made for these units are: (1) less time spent on maintenance, (2) greater economy of operation, (3) power economy, and (4) the ability to provide activated sludge treatment for smaller communities and isolated institutions. These package plants also have great usefulness in industrial waste treatment, but this will be the subject of a subsequent article. It strikes this author though, as being odd that very few operational reports have appeared in the journals from these package plants. Perhaps this emphasizes the simplicity of operation, but the author would appreciate receiving comments, reports, or complaints from any operators as a means of evaluating and improving these package plants.

Other Types of Package Plants

All the units discussed so far have been designed as secondary treatment plants. Primary treatment plants where the sedimentation and digestion processes occur in a single unit can also be called "Package" plants, although this is not usually done. Some of the equipment manufacturers have such units for sale under various copyrighted names.

Any wide-awake operator will immediately recognize a sedimentation-digestion unit by any name as being basically an Imhoff tank. However, each of the current package units of this type have some new features not found in standard Imhoff tanks. One

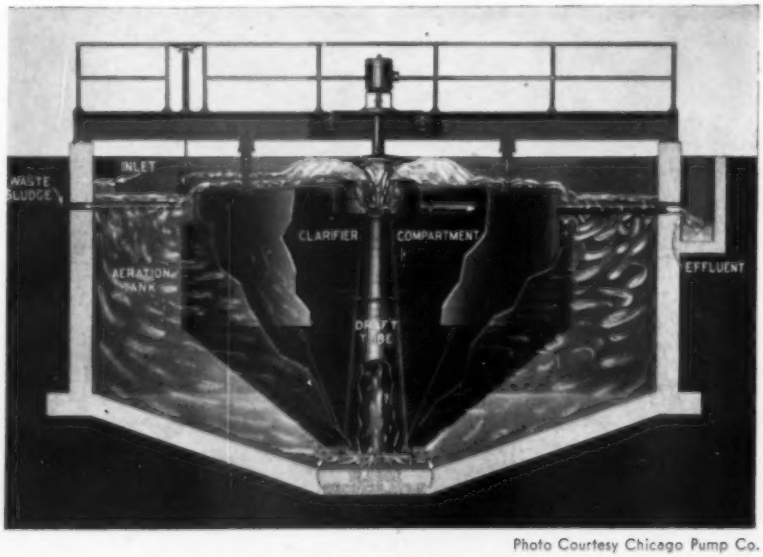


Photo Courtesy Chicago Pump Co.

Fig. 7—"AERATOR-CLARIFIER" design.

of these units is called a "Clarigester", another the "Spiragester" (Fig. 8). Since these operate like an Imhoff tank, not much need be said. The raw sewage enters the upper compartment where the velocity of flow is reduced. This allows the settleable solids and a portion of the suspended solids to leave the sewage and settle. The effluent is drawn off the top, while the solids settle into the lower section. Here digestion of the solids occurs. Provision is made for supernatent draw-off as well as for digested sludge removal. Devices are also provided for scum removal and sludge recirculation. This in effect then, is a single unit for primary sewage treatment.

In recent years many new variations of sewage treatment on filters have been brought forth. The next article in this series will discuss some of these.

References

(1) "Recent Developments in the Activated Sludge Process"—Jaffe, T. Water and Sewage Works J. 103: 9: 428 (1956).

(2) "New Equipment for the Activated Sludge Process"—Kalinske, A. A. and Busch, A. W.—Water and Sewage Works J. 103: 7: 325 (1956).

(3) "High Rate Chemical and Biological Treatment of Sewage"—Jaffe, T. and O'Sullivan, J.—Sew. & Ind. Wastes J. 24: 2: 149 (1952).

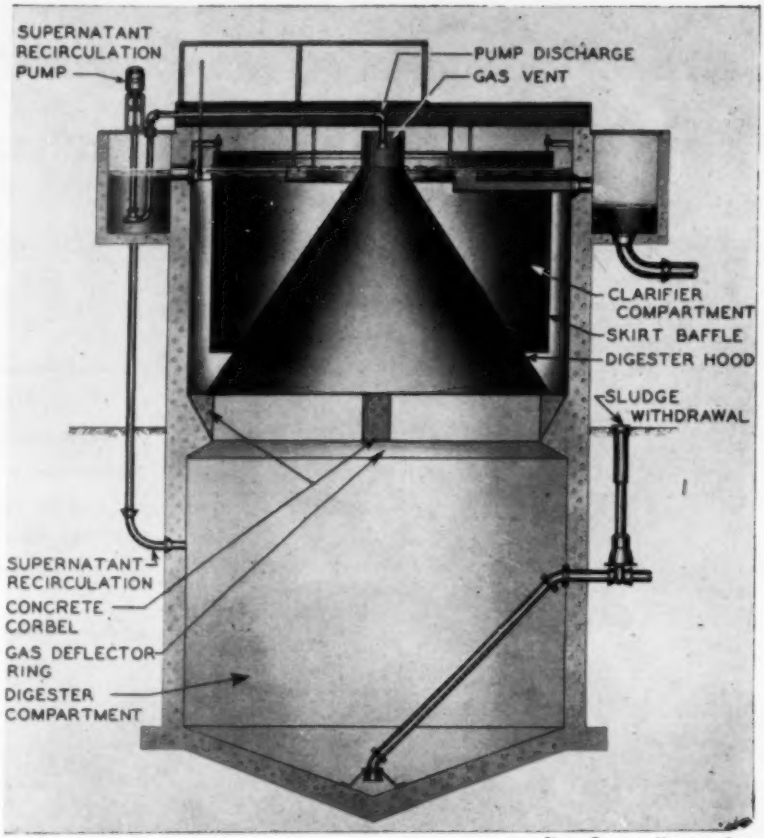


Photo Courtesy Yeomans Bros.

Fig. 8—"SPIRAGESTER" design for sedimentation and digestion.

Register of Dams in the United States

The U. S. Committee on Large Dams has undertaken the task of assembling and publishing vital data on important dams in the United States. The new publication, to be known as the "Register of Dams in the United States," will be a valuable reference document containing the names, dimensions and other salient facts on dams in this country. The names of the owner of the dam, the engineering firm responsible for its design, and the construction contractor will also be included. This compilation will serve to bring recognition to many designing, engineering, and contracting firms engaged in dam construction in this country. By means of this reference document, anyone seeking information regarding a dam structure will be able to have it at his fingertips.

Height alone will not be the primary consideration in determining whether or not a dam should be included in the Register. It is recognized that some dams, while not outstanding in size, incorporate interesting and complicated engineering features, many of which have become prominent through discussions and articles in technical journals. Photographs of the more prominent structures will be included in the Register.

Owners, engineering firms and contractors are urged to cooperate by contributing data available to them on structures that they own, have designed, or built. Necessary forms for recording the data or further information may be had from the chairman of the Committee on the Register of Dams, T. W. Mermel, 4540 43rd St., N.W., Washington 16, D.C.

Chairman of the U.S. Committee on Large Dams is F. S. Friel, Cons. Engr. of Philadelphia and Vice Pres. of ASCE.

WARNING!

In our May 1957 issue we published a nomograph for determining "FLOW in Rectangular Channels", or for determining channel design to accommodate anticipated flows.

We issue this warning to our readers that the nomograph has been found erroneous and should be destroyed. A corrected nomograph will be published as soon as the contributor, L. E. Livingston, Jr., of Dallas, Texas, supplies the corrected edition.

Alden Stilson & Associates Establish a Cleveland Office

Alden E. Stilson & Associates Ltd., consulting engineers with offices at 245 N. High St., Columbus, Ohio, have recently opened a second office in the Rose Bldg. at 2060 E. 9th St., Cleveland, Ohio.

Norman M. Wilkie is transferring from Columbus to take charge of the new Cleveland office, with Gordon Moellman assisting.

The new Cleveland office of Stilson & Associates is being established to better serve clients in the Buffalo-Chicago territory.

J. Stephen Watkins, Engrs. Establish Two New Offices

The J. Stephen Watkins Engineers of Lexington, Ky. announce the opening of two new offices—one in Louisville, Ky. at 4724 Preston St. Highway and another in Charleston, W. Va. at 107 Hale St.

The Charleston office will be under the direction of M. R. Hamill. The Louisville office will be under the direction of C. W. Lovell.

Immediate Oxygen Demand Removal From Digester Supernatant Liquor

What experimental high pressure aero-oxidation discloses.

by H. O. HALVORSON, Ph.D.

Dr. Halvorson, is Chairman of the Department of Bacteriology at the University of Illinois. In this article, he describes some interesting experiments showing how to remove the crippling immediate oxygen demand from sludge digester decant liquors.

MANY OPERATORS have suspected that the supernatant liquor from a digester cuts down the efficiency of secondary treatment. If this be so, it may well be due to a high immediate oxygen demand that robs the flora in the trickling filter and activated sludge plant of oxygen. This can happen because, when a liquid with a high immediate demand bathes the flora, the oxygen in the sewage may be used up faster than it can redissolve. At the best, oxygen is very sparsely soluble in water and the transfer rate into solution may be very low. If the dissolved oxygen is exhausted for moderately short periods of time, aerobic bacteria may die or be retarded in their growth so that secondary treatment ceases to function normally. To avoid this, it is wise to remove this immediate demand before the sewage is given secondary aerobic treatment.

Ed. Note: For the next year, Dr. Halvorson will be at the University of Trondheim in Norway as a Fulbright Professor. A former president of the American Society of Bacteriologists, Dr. Halvorson recently received a Guggenheim award for some of his work.

This suspicion became a conviction from some preliminary observations made on the digester operating on the yeast waste at the National Yeast Corp. plant at Crystal Lake, Illinois. It was found that the effluent from the digester had a 5-day B.O.D. of about 1500 ppm and that 300 ppm of this could be satisfied by merely whipping air into the liquid with a Waring blender. From preliminary studies it looked as though the immediate demand in this supernatant liquor was due to sulfides coming either from the organic sulphur or from the reduction of sulfates in the water. In any case, this observation led to the studies reported here involving laboratory and field tests to ascertain whether or not it would be practical to remove this immediate demand before the waste is discharged to secondary treatment.

Research has shown that it is commercially unfeasible and impractical to carry out the oxidation of the chemical and/or auto-oxidizable compounds under atmospheric conditions and in the absence of vigorous agitation. The use of atmospheric conditions requires many hours of pretreatment and, therefore, the use of super-atmospheric pressure is a practical necessity for the success of the operation. With pressure aeration, the immediate dissolved oxygen demand (I.D.O.D.) is satisfied in minutes rather than hours required with normal aeration.

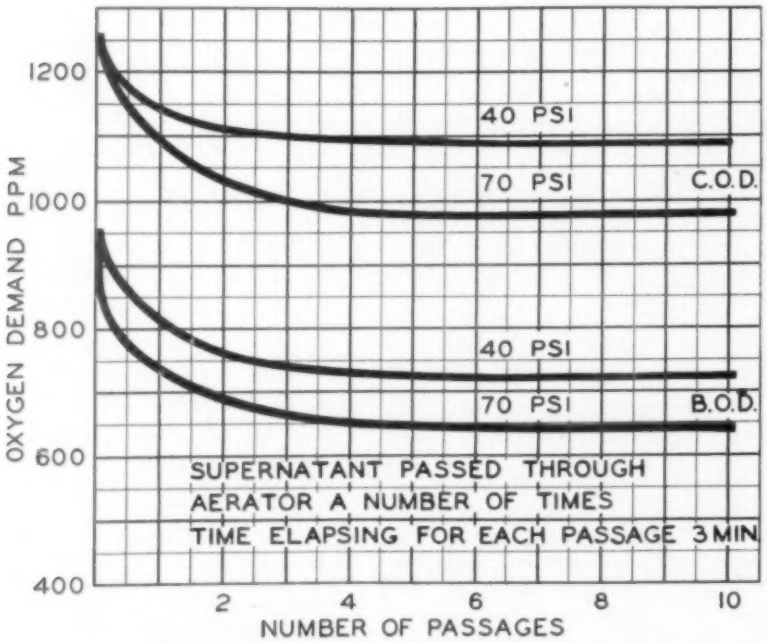


Fig.1—OXYGEN demand of yeast digester supernatant liquor—No catalyst used.

Materials and Methods

The laboratory tests in this study were made on digester supernatant liquors obtained from several plants: Crystal Lake, Rantoul and Urbana, Ill.; and Owatonna and Rochester, Minn. The field studies were made at Bensenville and Crystal Lake, Ill. Some tests were also made on a simulated supernatant obtained by adding sodium sulfide or sulfite to domestic sewage.

For the laboratory studies, the im-

mediate oxygen demand (I.O.D.) was determined by one of two methods. In one the directions specified in the "Standard Methods of Water and Sewage Analysis" were followed; i. e. a measured amount of the waste is added to diluting water in a B.O.D. bottle. This is allowed to stand 30 minutes, after which the remaining dissolved oxygen is measured in accordance with standard methods. The difference between the content of dissolved oxygen initially and after 30 minutes standing multiplied by the dilution gives the I.O.D. This is referred to later as Method A. In the other method (referred to as Method B) a regular 5-day B.O.D. determination was made on the sample before and after it had been aerated in a Waring blender for 5 minutes. The difference in the B.O.D. before and after aeration was regarded as the I.O.D.

In the analysis that was made in the field, a special pressure aeration unit manufactured by Yeomans Brothers Co. of Melrose Park, Illinois, was used. This device permitted the waste to be aerated in a closed chamber in the presence of air under pressure. The air and waste were mixed as they were pumped into the tank under pressure. After a few minutes' contact in the pressure tank, the liquid was released, after which the excess dissolved gas escaped. The oxygen demand was determined on a sample by the chemical method using the dichromate method (Porges et al; *Sewage & Industrial Wastes;* 22,318—1950). The difference between the oxygen demand before and after the aeration was regarded as the measure of the I.O.D. In this method, as in the laboratory studies, $CuSO_4$ was used as a catalyst to hasten the oxidation of the auto-oxidizable substances.

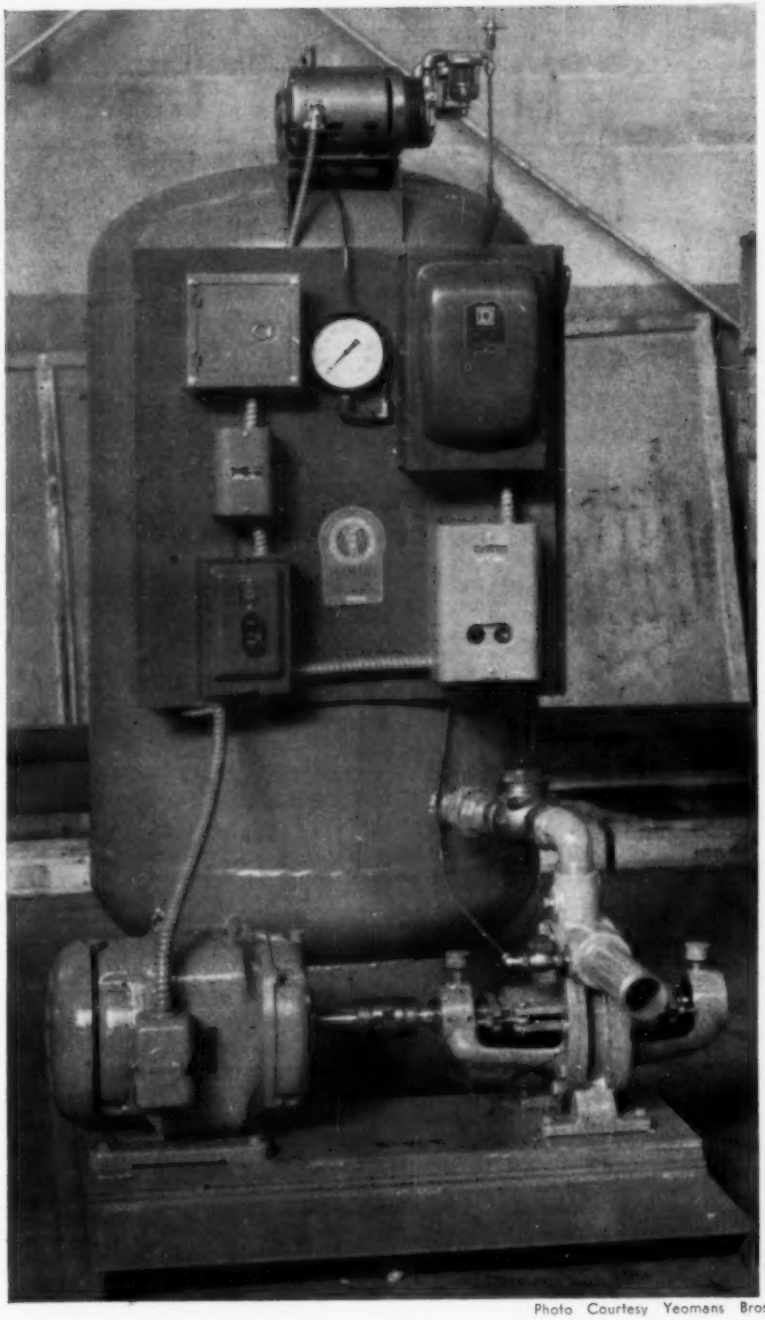


Photo Courtesy Yeomans Bros.

PRESAIRE® Supernatant Corrector used in field studies at Crystal Lake and Bensenville, Ill.

Experiments at Crystal Lake

It was mentioned, heretofore that some laboratory studies were made on the supernatant obtained from the digester serving the waste treatment plant at the National Yeast Corp. in Crystal Lake, Illinois. In this plant the yeast waste is pretreated by digestion in accordance with the teachings of Buswell. Using Method A, we found that this supernatant had an I.O.D. of 300 ppm with an initial 5-day B.O.D. of 1500 ppm. We also observed a rapid uptake of oxygen with this waste in a Warburg respirometer. Preliminary studies on this waste led us to believe that the I.O.D. here was due to a large extent to sulfides because a removal of the sulfides by precipitation resulted in a marked reduction in the I.O.D.

In the field studies at Crystal Lake, effluent from the digester was aerated under supera-atmospheric pressures with the special pressure aeration unit, mentioned above, and the I.O.D. and B.O.D. were determined on the waste before and after the aeration. The results are shown in Fig. 1.

Studies on Simulated Supernatants

Two simulated supernatant liquors were made, one by adding .237 grams of Na_2SO_3 to 100 ml of domestic sewage, and the other by adding .116 grams of Na_2S to 100 ml of sewage. The I.O.D. was determined on each of these by Method A before and after aerating for 5 minutes in a Waring blender. The results are shown in Table 1.

Three samples of simulated supernatants were made by adding to the first .0237 grams, to a second, .0474 grams and to a third, .237 grams of Na_2SO_3 to 100 ml of domestic sewage. Another similar set was prepared but with the addition of 3 ppm of $CuSO_4$ as a catalyst. The I.O.D. was determined on each of these six samples by Method A before and after aerating the samples for 5 minutes in a Waring blender. The results are shown in Table 2.

TABLE 1

Contribution of Sulfite and Sulfide to I.O.D.

Sample Containing	Immediate Oxygen Demand (I.O.D.) Before Aeration	After Aeration	Removed By Aeration
Na_2SO_3	280	230	50
Na_2S	150	96	54

TABLE 2

Effects of Copper Sulphate on the Removal of I.O.D.

Sample	Immediate Oxygen Demand Before Aeration	After Aeration	Removed By Aeration
Without Copper Sulphate			
.0237 gr. Na_2SO_3	29	3.7	25.2
.0474 gr. "	59	31.0	28.0
.237 gr. "	296	237.0	59.0
With Copper Sulphate			
.0237 gr. Na_2SO_3	29	0.0	29.0
.0474 gr. "	59	0.0	59.0
0.237 gr. "	296	5.0	291.0

TABLE 3

I.O.D. of Digested Supernatants

Supernatant	Parts per Million (ppm) B.O.D. Before Aeration	B.O.D. After Aeration*	I.O.D. Removed
Rochester, Minn., No. 1	2620	1420	1200
Rochester, Minn., No. 2	2600	2000	600
Owatonna, Minn.	495	495	0
Rantoul, Ill., No. 1	600	380	220
Rantoul, Ill., No. 2	400	400	0
Rantoul, Ill., No. 3	1090	950	140
Urbana, Ill.	1400	1200	200

*Five minute rapid mechanical aeration

TABLE 4

The Effect of Pressure Aeration on the Removal of the I.O.D. From the Digester Supernatant at Bensenville, Ill.

Date	Aerator Liquor	$CuSO_4$ Added ppm	C.O.D. Demand ppm	Air Input cfm	Flow gpm	Pressure psi
3/29/57	Influent	0	2550			
	Effluent	0	2020	1.2	34	60
	Effluent	1	1680	1.2	34	60
	Effluent	3	1600	1.2	34	60
4/2/57	Influent	0	1950			
	Effluent	0	1850	2.0	34	60
	Effluent	1	1840	2.0	34	60
	Effluent	3	1840	2.0	34	60
4/3/57	Influent	0	2048			
	Effluent	0	2040	1.2	34	60
	Effluent	1	2014	1.2	34	60
4/5/57	Influent	0	2649			
	Effluent	0	2308	1.2	34	60
	Effluent	1	2250	1.2	34	60

Laboratory Studies

On the various digester supernatants that were obtained 3 ppm of $CuSO_4$ was added to each of them as a catalyst and then the I.O.D. was determined by Method B; i. e., the 5-day B.O.D. on these supernatants were determined before and after aeration for 5 minutes with a Waring blender. The results are given in Table 3.

Field Studies

The supernatant from the digester at Bensenville was passed through the Yeoman's pressure aeration unit with and without the addition of $CuSO_4$. The results obtained are given in Table 4.

Discussion

It is obvious from the above that sodium sulfite or sodium sulfide can impart to sewage an I.O.D. which can be removed by adequate aeration. The oxidation of these compounds, however, is relatively slow in the absence of a catalyst and aeration at atmospheric pressures. With the addition of 3 ppm or more of $CuSO_4$ the oxidation becomes fairly rapid, so that the I.O.D. can be satisfied with a relatively short period of aeration. It has been noted that some supernatants had a fairly high I.O.D. while others had none, or at best, a very low demand.

It appeared to the author that this correlated with the odor of hydrogen sulfide coming from these supernatants. Those with the highest demand had a strong odor. It is likely, therefore, that the value of the I.O.D. may depend upon the amount of organic sulphur in the waste or the amount of sulfate in the water that can be reduced to sulfides by the action of anaerobic bacteria.

Of course, organic sulfur, such as in the amino acid cystine, occurs in proteins and urine so no domestic, packing plant, or creamery waste is without it. Hydrogen sulfide is a product of anaerobic decomposition of this material. It is also apparent from the above results that the I.O.D. can be satisfied by aeration preferably under pressure in the presence of small amounts of $CuSO_4$.

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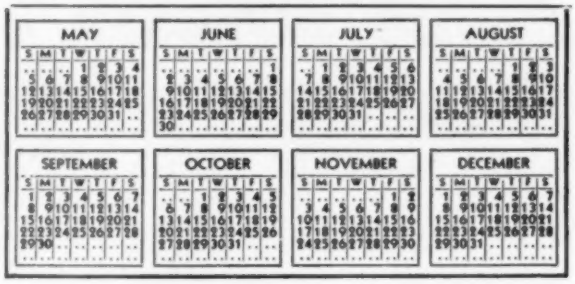


Aug. 8—Greenville, Maine
MAINE WATER UTILITIES ASSN., Secy., Gerard F. Laurin, 89 Western Ave., Augusta, Maine

Aug. 12-16—Blacksburg, Va. (*Va. Polytechnic Institute*)
VIRGINIA SHORT SCHOOL FOR OPERATORS WATER & SEWAGE TREATMENT PLANTS, W. A. Parsons, Assoc. Prof. San. Engr., Va. Polytechnic Institute, Blacksburg, Va.

Aug. 19-23—Durham, N. C. (*Duke University*)
NORTH CAROLINA WATERWORKS OPERATORS ANNUAL SHORT SCHOOL, Secy., Frank L. Ward, Jr., 116 North Ireland Street, Burlington, N. C.

Aug. 26-28—University Park, Pa. (*Pennsylvania State Univ.*)
PENNSYLVANIA WATER WORKS OPERATORS' ASSN., Secy., Harry A. DeWire, 29 Chestnut Street, Lewistown, Pa.

Aug. 28-30—University Park, Pa. (*Pennsylvania State Univ.*)
PENNSYLVANIA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., J. R. Harvey, c/o Pennsylvania Dept. of Health, 916 Diamond, Meadville, Pa.

Sept. 4-6—Milwaukee, Wis. (*Hotel Schroeder*)
WISCONSIN SECTION, A.W.W.A., Secy., Harry Breimeister, Chief Utility Engr., City Engineer's Office, City Hall, Milwaukee 2, Wis.

Sept. 11-13—Upper Saranac Lake, N. Y. (*Saranac Inn*)
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, Rensselaer Valve Co., c/o Ludlow Valve Co., 11 W. 42nd St., New York, N. Y.

Sept. 11-13—Sioux Falls, S. D. (*Sheraton-Cataract Hotel*)
23RD ANNUAL SOUTH DAKOTA WATER & SEWAGE WORKS CONFERENCE, Secy., Charles E. Carl, S. D. Water & Sewage Works Conference, Pierre, S. D.

Sept. 15-18—Boston, Mass. (*Hotel Statler—75th Anniversary Convention*)
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, N.E.W.W.A., 73 Tremont St., Boston 8, Mass.

Sept. 15-18—Baltimore, Md. (*Lord Baltimore Hotel*)
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Secy., F. J. Van Antwerpen, 25 West 45th Street, New York 36, N. Y.

Sept. 16-18—Pullman, Wash. (*State College of Washington*)
FIFTH BIENNIAL INLAND EMPIRE WATER WORKS SCHOOL, Prof. G. H. Dunstan, State College of Washington, Pullman, Wash.

Sept. 18-20—Cincinnati, Ohio (*Netherland Plaza Hotel*)
OHIO SECTION, A.W.W.A. Secy., M. E. Druley, Dist. Mgr., Dayton Power & Light Co., Wilmington, Ohio

Sept. 23-25—Louisville, Ky. (*Brown Hotel*)
KENTUCKY-TENNESSEE SECTION, A.W.W.A., Secy., J. Wiley Finney, Jr., Howard K. Bell, Cons. Engrs., 553 S. Limestone Street, Lexington, Ky.

(*Jointly With*)

KENTUCKY-TENNESSEE INDUSTRIAL WASTES & SEWAGE WORKS ASSN., Secy., S. Leary Jones, Cordell Hull Bldg., Nashville, Tenn.

Sept. 24-25—Santa Fe, N. M. (*La Fonda Hotel*)
ROCKY MOUNTAIN SECTION, A.W.W.A., Secy., Jack W. Davis, Dist. Mgr., Transite Pipe, Johns Manville Sales Corp., 301 Continental Oil Bldg., Denver 2, Colo.

Sept. 25-26—Stillwater, Okla. (*Oklahoma A & M College*)
OKLAHOMA INDUSTRIAL WASTES CONFERENCE, Prof. Quintin B. Graves, Oklahoma A & M College, Stillwater, Okla.

Sept. 25-27—Detroit, Mich. (*Leland Hotel*)
MICHIGAN SECTION, A.W.W.A., Secy., T. L. Vander Velde, Chief, Sec. of Water Supply, State Dept. of Health, Lansing 4, Mich.

Sept. 25-27—Fargo, N. D. (*Gardner Hotel*)
NORTH CENTRAL SECTION, A.W.W.A., Secy., Leonard N. Thompson, General Manager, Water Dept., St. Paul 2, Minn.

(*Jointly With*)

NORTH DAKOTA WATER & SEWAGE WORKS CONFERENCE, Secy., Jerome H. Svore, c/o State Dept. of Health, Bismarck, N. D.

Sept. 29-Oct. 1—St. Louis, Mo. (*Hotel Sheraton Jefferson*)
MISSOURI SECTION, A.W.W.A. AND MISSOURI WATER & SEWAGE CONFERENCE, Joint Meeting, Secy., Warren Kramer c/o State Office Bldg., 6th Floor, Jefferson City, Mo.

Oct. 7-10—Boston, Mass. (*Hotel Statler*)
FEDERATION OF SEWAGE & INDUSTRIAL WASTES ASSNS., Ralph E. Fuhrman, Exec. Secy., 4435 Wisconsin Ave., N. W., Washington 16, D. C.

Oct. 8-11—Atlantic City, N. J. (*Chalfonte Hotel*)
PENNSYLVANIA WATER WORKS ASSN., Secy., David Dunlap, 2609 N. Second Street, Harrisburg, Pa.

Oct. 10—South Paris, Maine
MAINE WATER UTILITIES ASSN., Secy., Gerard F. Laurin, 89 Western Ave., Augusta, Maine

Oct. 13—16—Oklahoma City, Okla. (*Municipal Auditorium*)
SOUTHWEST SECTION, A.W.W.A., Secy., Leslie A. Jackson, Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

Oct. 14-18—New York, N. Y. (*Hotel Statler*)
AMERICAN SOCIETY OF CIVIL ENGINEERS, Exec. Secy., W. H. Wiseley, 33 W. 39th Street, New York 18, N. Y.

Oct. 16-18—Des Moines, Iowa (*Fort Des Moines Hotel*)
IOWA SECTION, A.W.W.A., Secy. J. J. Hail, Supt., Water Dept., City Hall, Dubuque, Iowa

Oct. 17-18—Halifax, Nova Scotia (*Nova Scotian Hotel*)
CANADIAN SECTION, A.W.W.A., 10th Annual Meeting—Maritime Branch, Secy. J. D. Kline, Pub. Service Comm., P. O. Box 608, Halifax, N. S.

Oct. 20-23—Biloxi, Miss. (*Buena Vista Hotel*)
ALABAMA-MISSISSIPPI SECTION, A.W.W.A., Secy., C. M. Mathews, Asst. Supt., Public Service Comm., 19 West Commercial Street, Yazoo City, Miss.

Oct. 23-24—Wheeling, W. Va. (*McLure Hotel*)
WEST VIRGINIA SECTION, A.W.W.A., Secy., Hugh W. Hetzer, Engr., West Va. Water Service Co., P. O. Box 1906, Charleston 27, W. Va.

(*Jointly With*)

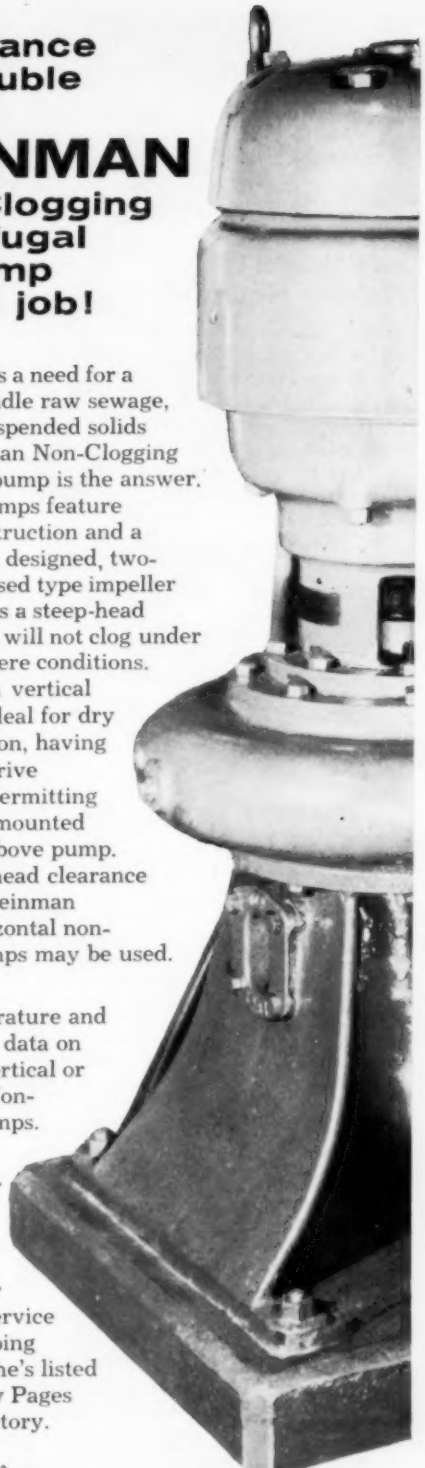
WEST VIRGINIA SEWAGE & INDUSTRIAL ASSN., Secy., G. O. Fortney, c/o State Dept. of Health, Charleston 5, W. Va.

Oct. 24-26—Atlantic City, N. J. (*Hotel Madison*)
NEW JERSEY SECTION, A.W.W.A., Secy., Albert F. Pleibel, 683 Prospect Street, Maplewood, N. J.

Oct. 24-26—Seattle, Wash. (*Franklin Hotel*)
PACIFIC NORTHWEST SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Gilbert H. Dunstan, State College of Washington, P. O. Box 176, Pullman, Wash.

(*Continued on page 110A*)

No chance for trouble with a WEINMAN Non-Clogging Centrifugal Unipump on the job!



- When there's a need for a pump to handle raw sewage, sludge or suspended solids . . . a Weinman Non-Clogging centrifugal pump is the answer.

These pumps feature rugged construction and a scientifically designed, two-vaned, enclosed type impeller that produces a steep-head capacity and will not clog under the most severe conditions.

Weinman vertical pumps are ideal for dry pit installation, having a flexible drive connection permitting motor to be mounted any height above pump. Where overhead clearance is limited, Weinman Class B horizontal non-clogging pumps may be used.

- Send for literature and performance data on Weinman Vertical or Horizontal Non-Clogging pumps.
- Contact your nearest Weinman Pump Specialist for immediate service on any pumping problem . . . he's listed in the Yellow Pages of your directory.

Find your nearest representative in the 'Yellow Pages'

Weinman Class VM Vertical Non-Clogging Unipump with close-coupled motor drive.

THE WEINMAN PUMP MFG CO.
290 SPRUCE ST. COLUMBUS 8, OHIO

W&SW

Spillway

OVERFLOW FROM THE MAIN SECTION

And Now, It's Professor Hedgepeth

L. L. Hedgepeth has been appointed by Rutgers University as Adjunct Professor. He will assist in the activities of the Department of Sanitation in teaching and research on a part time basis. Mr. Hedgepeth will continue in his present position with the American Cyanamid Co. as senior consultant in water sanitation.

Water & Sewage Works has been fortunate to have "Hedge" as a valued member of its advisory Panel of Editorial Associates.

Annual Reports Received

Among the annual reports received recently are the following:

LITTLE ROCK, ARK. (Water Works)—This is a 72-page booklet prepared under the direction of the Board of Water Commissioners and L. H. Jackson, Manager-Engineer. The report covers the year 1956 and includes statistics on the physical plant, meterology, population, water consumption, operation of the purification plant, pumping plant operation, distribution system, as well as water rates and financial statistics.

* * *

AUBURN, ME. (Water Works—A 26-page report issued by the Auburn Water District, S. S. Anthony, Superintendent, includes data and information on the physical plant as well as the operation, income and expenses and other pertinent data. Also included in the booklet is a section on the Auburn Sewage District.

* * *

ATHOL, MASS. (Water Works)—A 24-page report, being the 51st Annual Report, of the Water Commissioners for the year ending December 31, 1956. The report covers maintenance and construction, filtration plant, organization and operating data.

* * *

INDIANAPOLIS, IND. (Water Works)—The 75th Annual Report of the Indianapolis Water Co. is a 32-page booklet containing information on the revenues and earnings, expenses, water usage and customers, property additions, comparative statistics of progress, a water shed map, personnel, accountant's report, balance sheet, service area map and other data pertinent to the subject.

* * *

BOISE, IDAHO (Sewage Works)—Sixth Annual Report Sewage Treatment Plant for 1956. This report, prepared by H. A Wall, Supt., contains a description of the plant, design flow data, cost data, sewer service charges, maintenance data, sewer maintenance review, personnel, plant activities, report on renting sewers, laboratory, sampling and technique and recommended plant program for 1957.

* * *

CHICAGO ILL. (Public Work, Dept.)—A 32-page report prepared under the direction of George L. De-Ment, Comm. of Public Works. Primarily a photographic report with photo diagrams and explanatory text, the contents include the functions and organization, super highways, subways, parking facilities, bridges, water works, sewers, waterways, public buildings, aviation, recreation, forestry and maps. A financial summary is also included.

* * *

Pickups from Purdue's "Sanitary Engineering News"

Don E. Bloodgood, Editor

The sewage treatment plant at Tiberias, Israel, is 600 feet below sea level.

* * *

Portable cleaning equipment employing a steam jet is used by Arthur Niles at Toledo, Ohio, to keep his plant clean.

* * *

Baxter Springs, Kansas, has the first municipal installation of equipment for softening by continuous base exchange.

* * *

Automation Grows in Water Industry

There is a trend in water works operations toward automation to improve service and to minimize rising costs, according to a report by Minneapolis-Honeywell's Industrial Div.

This year expenditures for expansion of water reservoirs and facilities, both public and private, will run close to $800 million. Automatic control devices and systems for regulating and monitoring water treatment plants will be an integral part of these building and modernization programs, the report says.

In general the control systems harness a variety of pneumatic and electronic units to regulate flows, measurement and control of treating chemicals, levels and the critical aspects of various filtration stages.

A Useful Table

Weight and Volume

1 gal. (U.S.)	=	231. cu. in. 0.13368 cu. ft.
1 Imperial gallon	=	277.274 cu. in.
1 cu. ft.	=	7.4805 gal. 1728 cu. in.
1 cu. ft. water at 60° F	=	62.37 lb.
1 cu. ft. water at 212° F.	=	59.76 lb.
1 gal. water at 60° F	=	8.34 lb.
1 gal. water at 212° F	=	7.99 lb.
1 lb. (avdp.)	=	16 oz. 7000 grains
1 bushel	=	1.244 cu. ft.
1 short ton	=	2000 lb.
1 long ton	=	2240 lb.

Pressure

1 lb. per square inch	=	144 lb. per square foot 2.0416 in. mercury at 64° F. 2.309 ft. water at 62° F. 27.71 in. water at 62° F.
1 oz. per square inch	=	0.1276 in. mercury at 62° F. 1.732 in. water at 62° F.
1 atmosphere	=	14.7 lb. per square inch 2116.3 lb. per square foot 33.974 ft. water at 62° F. 30 in. mercury at 62° F 29.921 in. mercury at 32° F.
1 in. water at 62° F	=	0.03609 lb. per square inch 0.5774 oz. per square inch 5.196 lb. per square foot
1 ft. water at 62° F	=	0.433 lb. per square inch 62.355 lb. per square foot
1 in. mercury at 62° F	=	0.491 lb. per square inch 7.86 oz. per square inch 1.131 ft. water at 62° F. 13.57 in. water at 62° F.

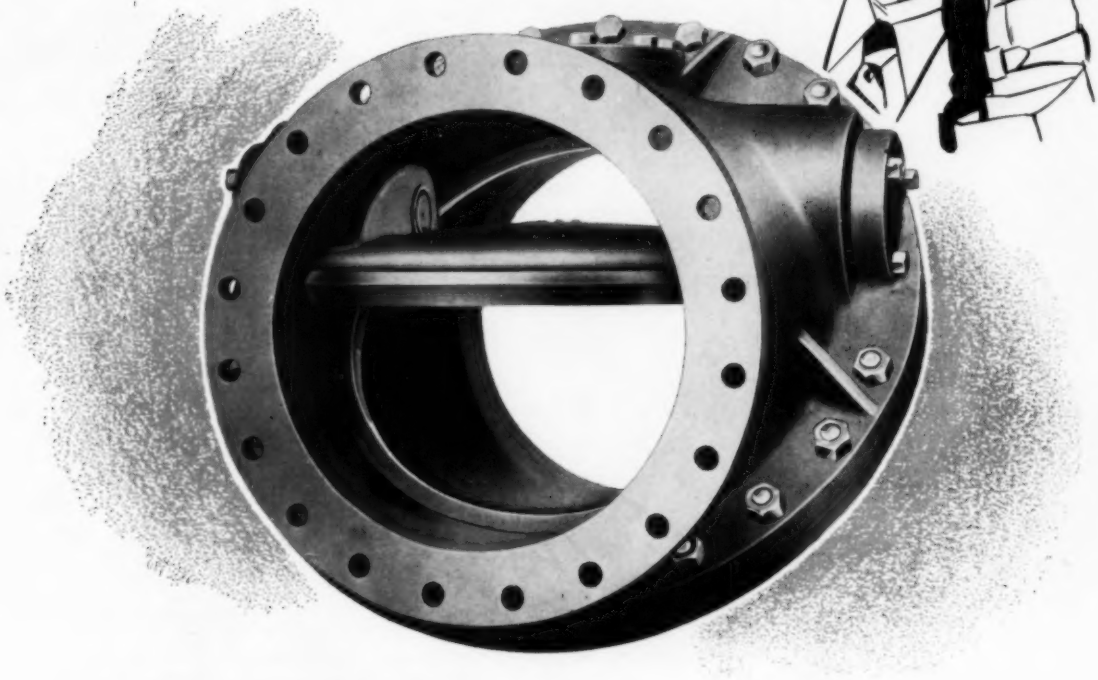
Power, Work, Etc.

1 ton refrigeration	=	199.038 Btu per minute
Latent heat of ice	=	143.33 Btu per pound
1 Btu	=	776 ft.-lb. 0.293 watt-hours 252.02 mean calories
1 watt hour	=	2,655.2 ft.-lb. 3.415 Btu. 3600 joules 860.648 mean calories
1 mean calorie	=	0.003968 Btu. 3.085 ft.-lb. 0.0011619 watt-hours
1 kilowatt (1000 watts)	=	1.3405 horsepower 56.92 Btu. per minute 44,252.7 ft.-lb. per minute
1 horsepower	=	0.746 kilowatt 42.44 Btu. per minute 33,000 ft.-lb. per minute 550 ft.-lb. per second
1 boiler horsepower	=	33,523.7 Btu. per hour

**From Tech. Data File 77-5101 Minneapolis-Honeywell Regulator Co.*

You have to see it to believe it . . .

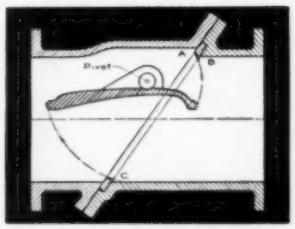
(You Can't Hear It!)



CHAPMAN Tilting Disc Check Valve

It's the silent valve. No noise, no vibration, no fluttering. On usual piping arrangements you get no slamming with a Chapman Tilting Disc Check Valve. You get no banging to cause damage to system or valve . . . no grinding, scraping or wearing of either the disc or seat. Your maintenance costs go down to an unbelievable low which is really something to see and enjoy.

You can safely use these valves under tough operating conditions. You can order them in iron and steel . . . for handling fluids or gases under a wide range of pressures. You can get them fast. See our Catalog 30-A. Write for your copy today.



Look at this operational chart. When the flow is on, "airfoil" disc is held firmly against stops in the body. When the flow drops, disc balances quietly on whatever flow there is. When flow stops, disc drops quickly, quietly and firmly on special bevel seat. Note that sufficient space is designed around disc to cut down flow resistance.

THE CHAPMAN VALVE MANUFACTURING CO.
INDIAN ORCHARD, MASSACHUSETTS

"WATER, WATER - - - - - !"

Atlanta's "Willing Water" made the plea all over town: "Keep it flowing by voting for Water Works Bonds—rain or shine!"

Pamphlets and Booklets Available

Among the recent pamphlets which have become available are the following:

"Netherlands Specifications for Pipes Made of Hard Poly-Vinyl Chloride and soft Polythene". This is Communication #1 of the Comm. for Plastic Water Pipes of the Institution for Testing Water Works Materials in the Netherlands. This 44-page booklet is printed in English and contains the results of experience with these materials plus specifications for the materials for use in water works applications, particularly for household service pipelines. Use for main pipes is also included.

* * *

"Recommended Practice for Design, Equipment and Operation of Swimming Pools and Other Public Bathing Places". This is the 10th Ed. of the booklet first published in 1946. It has been revised and brought up to date. As the previous editions, this one has been accepted as an official report by each of the sponsors which include the Conf. of State Sanitary Engineers and the Am. Pub. Health Association.

The report has been revised and detailed throughout. In addition the following specific changes or additions are included: A statement on private fill and draw pools and a description of water level deck type have been added. The discussion of chlorination has been changed to give an upper limit of 1 ppm in usual chlorination and to recognize high free residual chlorination with residuals more than 1 ppm. A statement on surface skimmers has been added and a report on experiences with diatomaceous earth filters is included. The 60-page book can be obtained for $1.00.

* * *

9th Annual Report of the N. Eng. Pol. Control Comm.

With a foreword by William S. Wise, Chairman of the N. E. Interstate Water Pollution Control Commission, a 32 page report has been issued for the year of 1956.

The report contains sections of administration, commission activities, public relation, water resources, state programs, construction in the several states, industrial waste research, legislation, and finances. A copy of the report may be obtained from Jos. C. Know, Secy., 73 Tremont St., Boston 8, Mass.

Indianapolis Water Co. Issues 75th Anniversary Report

In 1956, the Indianapolis Water Co. completed its 75th year as a corporation devoted to serving the public. A special annual report was issued to commemorate the accomplishment. The 32 page booklet is a prime example of how a good public relations department can "sell" a water works utility to the customers. Persons who are interested in this fine report should write to J. E. Kleinhenz, Asst. to the Exec. Vice Pres., Indianapolis Water Co., 113 Monument Circle, Indianapolis, Ind.

SURE, "Sis" I called Mr. Jones, cause I heard you say there would be a drip here tonight.

An International Exhibition for Water Purification and Waste Water Treatment

The first exhibition ever held in Switzerland dealing with the purification of water and measures for abatement of pollution of waterways will take place in the premises of the Swiss Industries Fair at Basel from 25th January to 2nd February 1958. The object of this exhibition is to provide firms in Switzerland, and in other countries, with the possibility of bringing to the notice of wide circles of those interested the result of their efforts and achievements in everything affecting the purification of water and the treatment of waste water.

Within the framework of the exhibition itself there will also be a Congress on the effective treatment of waste water which will last for several days and at which prominent foreign and Swiss speakers will deal with the various aspects of this important question. It should be added that the basic Swiss Federal law for the protection of rivers and waterways came into force on the 1st of January 1957.

It is fully expected that the exhibition and the congress will arouse great interest and, for this reason, it is advisable that those concerned with water purification and/or waste treatment should seize this opportunity to take part in the exhibition.

Investment Firm Issues Report on Water Needs

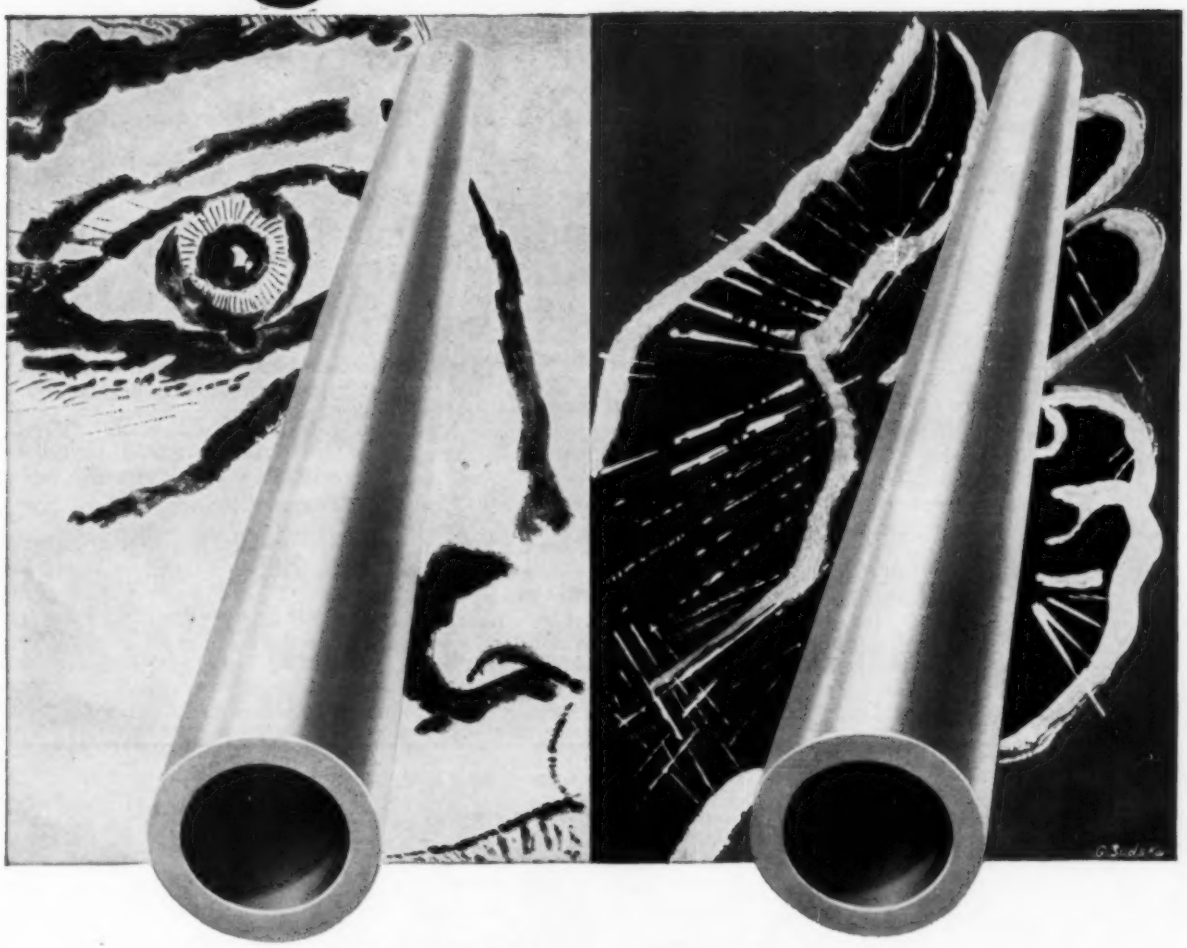
Dominick and Dominick, investment banking and brokerage house has issued a 19 page brochure on the shape and size of a long-range construction program to meet the country's expanding requirements for water. Special emphasis is placed upon the meaning to investors of a major water program.

The report outlines the rapidly rising demand for water, the uneven distribution of the national water supply, and estimates the rate and type of construction required to bring the two into balance in the years ahead.

Entitled "America's Water Needs —Their Investment Significance," the report states that opportunities for companies manufacturing water handling and conditioning equipment are substantial. A number of companies, selected by Dominick & Dominick as being representative of this group, are described in the report.

Copies are available from Dominick & Dominick, 14 Wall Street, New York 5, New York.

USCOLITE PLASTIC PIPE



Look alike... Feel alike

BUT AS DIFFERENT AS DAY AND NIGHT

It's a fact: Given the same raw materials, finished plastic pipe can be as different as day and night. The difference is in the techniques of compounding and manufacture.

For instance, these two lengths of plastic pipe, when new, have the same appearance, the same "feel", even the same weight. Both are used to carry the same corrosive chemicals. Yet one pipe failed in just a few months—the other pipe still shows no sign of wear after several years of service.

What's the difference? The *long-life* plastic pipe (on the right) is Uscolite®, and that means *quality*—the use of undiluted virgin resins, superior extrusion techniques, precision dimensions, quality control all the way.

When you order Uscolite—either Uscolite CP (modified alloy) or Uscolite RV (polyvinyl chloride)—you're getting plastic pipe with a reputation that has been proven by 8 years of service. And in all that time, *not one foot of Uscolite Pipe has ever been replaced.*

For your next plastic pipe and fitting installation, select carefully—select Uscolite. A complete line of pipe and fittings (including unique UscoWeld® fittings) plus the assistance of trained sales engineers who *know plastics*—is available at the 28 "U. S." District Sales Offices, at selected distributors, or contact us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.

Mechanical Goods Division

United States Rubber

Southern California To Have More Water

The Metropolitan Water District has scheduled for this summer, the start of additions to its Colorado River Aqueduct. The work will consist of the fabrication and installation of 47 inverted siphons along a 183-mile segment of the aqueduct to help bring the water supply line to its full planned delivery capacity of more than one billion gallons of water a day. The aqueduct is now delivering approximately half that amount to thirsty Southern California.

The initial construction of the aqueduct was completed in 1941. In it the siphons, which carry the water across drainage channels, canyons, desert washes and other depressions, were designed for a second barrel, to be completed later. Other portions of the aqueduct, including 92 miles of tunnels, 63 miles of concrete-lined canals and 54 miles of concrete conduits, were built to their ultimate capacity in the initial development.

In 1953, under the direction of General Manager and Chief Engineer Robert B. Diemer, the Metropolitan Water District embarked on a program to bring all of its facilities to their ultimate capacity. The District is now engaged in a $200 million expansion program which includes enlarging the distribution system; the addition of six more pumps at each of the five pumping stations on the main aqueduct (two of these six are now installed); doubling the capacity of Lake Mathews, the terminal reservoir of the main aqueduct near Riverside, from 107,000 acre-feet to 225,000 acre-feet; enlarging the softening and filtration plant near La Verne; a second aqueduct to San Diego, and the construction of the aforementioned 47 siphons.

The pipe fabrication and installation work on the second barrel of the siphon will be performed by the American Pipe and Construction Company under two contracts totaling nearly $16 million.

All siphons in the first barrel of the aqueduct, with one minor exception were constructed of cast-in-place reinforced concrete pipe. However, all 47 siphons of the second barrel will be constructed of precast, reinforced concrete pipe.

To bring the aqueduct to its ultimate capacity of 1,800 cubic feet per second, the second barrel of the siphons will have an inside diameter of 13 feet 6 inches for a portion of the siphons and 13 feet for the remainder. The pipe sections will be fabricated in 16 foot lengths weighing between 62 and 68 tons each.

Because of the size of the pipe and the distance involved the pipe company will erect a semi-portable field plant in the desert to produce the pipe. It first will be located near Desert Hot Springs and later at Freda Siding, near Rice.

In December, 1957 the plant will be moved to the easterly location near Rice and will continue to manufacture the remaining joints of 13 foot pipe which are scheduled for completion by February 1, 1958.

The Metropolitan Water District's overall expansion program, is scheduled for completion in 1960. The supplemental Colorado River water made available by this work will be enough to supply an additional 4,000,000 people in Southern California.

Fluoridation on Increase in Tennessee

The Sanitary Engineering Division of the Tennessee Dept. of Health reports that five cities have begun water fluoridation since the first of the year —representing a population increase of 100,000. Now, 35 Tennessee communities (total population 600,000) are receiving fluoridated water.

The largest water tank repair company in the United States is at your service. Repairs guaranteed for 12 years—paint for 3 years.

Representatives in every state of the Union.

DIXIE TANK'S "SYMBOL" OF YOUR PROTECTION

DIXIE TANK & BRIDGE CO.

P. O. BOX 14, MEMPHIS 1, TENN.

Please write or wire us for more information.

Indianapolis Water Co. Finds It Pays to Reward Employees Making Helpful Suggestions

Indianapolis Water Co. still maintains a Suggestion Box for employees' use in making suggested improvements in operation, management, or maintenance. For a number of years, I. W. Co. has found that the Suggestion Box is profitable to the water company, as well as to the employees making useable suggestions. Only last month three employees supplied award winning suggestions. One such suggestion was that the Company notify customers when "bad or hazardous conditions" are found surrounding the water meters, or the pipes by the meter readers.

Water Supply Project Nears Completion at West View, Pa.

A project started more than two years ago by the Municipal Authority of the Borough of West View, (near Pittsburgh) Pa., to provide water for many industries and over 100,000 persons is nearly completed.

Installation of two 700-foot long submarine cables—supplied by National Electric Products Corporation, Pittsburgh—and the laying of a 24-inch water line mark the final phase in developing the "push button" water supply system.

With this equipment installed, according to W. J. Murdoch, Pittsburgh, consulting engineer for the West View Water Authority, it will be possible to push a button on Neville Island, starting pumps on Davis Island, which in turn will deliver between 10 and 15 million gallons of water daily to Neville.

The power cable, which will deliver electricity for operating four 4,000 gallon per minute pumps, is a 5,000 volt submarine cable. Because it will be buried in the river, it wears several layers of special insulation.

Work began two years ago and included construction of a horizontal water collector or Ranney well. This water collector consists of a 16-foot-diameter concrete casing which rises from 65 feet below the river bed to 30 feet above the water surface. Water is brought into the collector from slotted pipes which are installed like spokes in a wheel around the base of the concrete casing. The pipes extend into natural deposits of water bearing gravel. Water flowing through the pipes into the casing is pumped into the pipe which leads from Davis to Neville Island.

Installation of 18" Pratt High Pressure Rubber Seat Butterfly Valve in prestressed concrete water main, Mansfield, Ohio. Engineers: Shaffer, Parrett and Associates.

MANSFIELD...Pratt Butterfly Valves meet all specs for distribution service

The real test of a distribution valve is its ability to operate when needed. Valves in water distribution service are primarily emergency measures, normally left either open or closed for months, or even years. Yet, they must operate when needed, often to prevent serious property damage in the event of a broken water main.

Mansfield engineers chose Pratt High Pressure Rubber Seat Butterfly Valves for this rigorous duty because Pratt valves meet all specifications for distribution service. The critical disc edge is a corrosion-resistant material, seating against a heavy, mechanically retained rubber liner to provide **permanent, drop-tight shutoff.** The stainless steel valve shaft rotates in bronze bearings, self-lubricated for life, and the valve operator is permanently lubricated and sealed. These features are your assurance of easy operation when you need it... features that are built into Pratt valves with the experience that comes with 30 years of leadership in butterfly valve design. Specifying Pratt valves puts this experience to work for you.

NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.

Write for Manual B-2B.

HENRY PRATT — RUBBER SEAT Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

W&SW

New Equipment

Economy Backhoe

801

Shawnee Manufacturing Co., Topeka, Kansas, has introduced a new Shawnee backhoe similar to a scaled-down version of the popular "Scout."

Called the "D 65", it digs 9½ feet deep, reaches 15 feet, and the hydraulic system provides 6200 pounds of digging force at the bucket teeth. No hydraulics are required on the tractor. The new model has been tested and approved by International Harvester for mounting on the "130"—it may also be mounted on other make light industrial tractors. Utility bucket widths are available from 12 to 24 inches, inclusive, and grave buckets from 32 to 36 inches, inclusive.

According to the company, the economy package is priced far below prevailing costs of backhoes with similar performance.

EASY TO
INSTALL CUTTING-IN
VALVES FOR BETTER
CONTROL
MH
MECHANICAL JOINT
M & H Cutting-In Valves and Cutting-In Sleeves have mechanical joints designed to work with various classes of cast iron pipe. By cutting a short section of correct length out of an existing pipe line, the Sleeve and Valve are easily installed by unskilled workmen. The Cutting-In Valve is the same design, construction and materials as M & H A.W.W.A., double disc gate valves, except for the mechanical joint and connections designed to work with various outside diameters of different classes of pipe. These valves are available with O-Ring seal or conventional stuffing box. Sizes, 4" through 12". Write or phone for details.
M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF
WALWORTH

Water Filter For Deep Wells

802

Filtros Inc., East Rochester, N. Y., has introduced a new model D "Flo-Clear" filter made long and slim to fit down inside cased wells, for use with deep well pumps.

Standard 1¼ inch pipe fitting in the end of the filter makes it easy to attach to the supply line in the well. A plug at the bottom can be removed so that one or more extra filters can be fastened on end-to-end for even greater capacity and less frequent cleaning. Its 3½ inch overall diameter permits it to be used inside a cased well as small as 4 inches in diameter. The filter is available in coarse, medium or fine pore size for various water conditions.

Orangeburg Introduces New Plastic Pipe

803

Orangeburg Manufacturing Co., Inc., Orangeburg, N. Y. and Newark, Cal., has announced that it has commenced production of Orangeburg SP Plastic Pipe, manufactured from Allied Chemical & Dye Corporation's new-type polyethylene resin, and demonstrating "working pressures, heat resist-

ance, of stress cracking and resistance to chemicals, organic solvents and hydro-carbon liquids, superior to any polyethylene pipe yet produced."

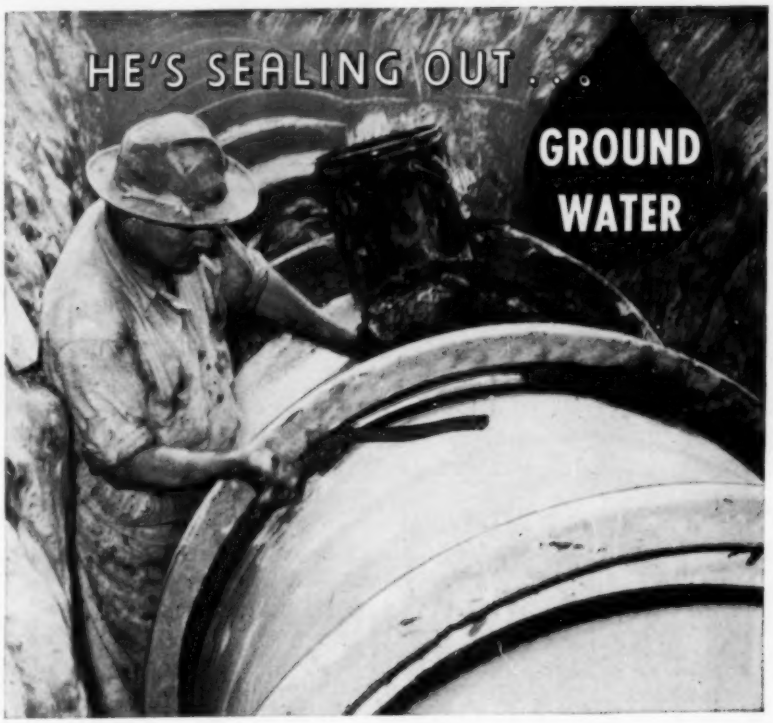
This new pipe, made by Orangeburg and to be marketed under the 'Orangeburg' brand, is available in ½" through 2" sizes and carries the National Sanitation Foundation approval for potable water service. Being stronger, it is somewhat less flexible than pipe made from conventional polyethylene. However, it retains sufficient flexibility to permit easy laying in the field and will come in coil lengths up to 400 feet.

Close Control Aids Large-Meter Tests

804

Rockwell Manufacturing Co., Pittsburgh, Pa., has announced that the rate-of-flow control valve, a 6-inch Rockwell-Nordstrom lubricated plug valve, at the Long Beach, Calif., Water Department's large-meter test facility, has been adapted for extremely accurate flow control. The plug valve is worm-gear operated rather than lever operated, and the exposed gearing is enclosed by a cover plate on which a quadrant—graduated in quarter-turns of the handwheel—has been placed to indicate the position of the plug.

Once set, the rate of flow does not change throughout the entire meter test period. Electrodes within the calibrated test tanks operate in connection with a special electrical recorder atop the meter to be tested, controlling the length of the test period without further movement of the main control valve. The Long Beach system is thought to be the only one of its kind currently in use.



. . . with Presstite's
3-STEP SEWER SEALING SYSTEM

To keep ground water infiltration out, and prevent sewage overload, this installation is getting Presstite's full, **watertight** treatment.

1 PRESSTITE PRIMER, painted on bells and spigots 24 hours before laying, greatly improves bond between pipe and joint sealing compound.

2 ROPAX® (shown being caulked in), a non-porous adhesive packing, provides additional joint sealing material. When packed into the bell, it forms a solid, dense seal impervious to water passage.

3 KALKTITE,® a cold-mixed, cold-applied joint sealing compound, used to fill the balance of bell. Sets up **internally** under the most adverse conditions. Forms a dense, tough, flexible seal.

WRITE for detailed catalog "3 Steps to Tighter Sewer Joints"

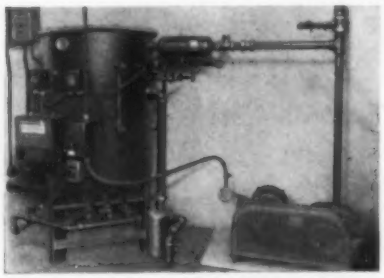
PRESSTITE SEALING COMPOUNDS
PRESSTITE-KEYSTONE ENGINEERING PRODUCTS COMPANY
K A P

A Division of AMERICAN-MARIETTA COMPANY
3780 CHOUTEAU AVENUE, ST. LOUIS 10, MISSOURI

Carbonation Units For Small Water Plants

805

Walker Process Equipment Inc., Aurora, Ill., has developed a small series of "Carball" units—sizes "O" and "00. With the addition of this new small line, the company now offers carbonation units for all lime softening plants from the very small to the largest. Specifically designed for water plants of 2 MGD and less, this bubbler contact cooler line of Carballs has been thoroughly field-tested for over a year. With capacities ranging from



55 to 660 pounds CO_2 per day, these units are intended for lime softening plants as small as 100 gpm, and may be used in plants up to 1,400 gpm.

This package system operates on either methane or propane gas and will produce CO_2 for around a cent a pound. The new units are shop assembled package units, used with Sparjer CO_2 diffusion systems and are engineered for each application.

"Stopper" For Large Diameter Pipe

806

Vanderlans & Sons, Lodi, Calif., has developed the Lansas Sewerplug. This device is designed to provide a simple, reliable means of "stoppering" large diameter pipes for test, inspection or repair work.

Consisting of a grooved cast aluminum disc with an inflatable heavy-duty tube around its circumference, the Sewerplug effectively stops even high pressure flow in the pipe with only 40 psi or less air pressure in the sealing tube.

The Sewerplug is available in standard 6, 8, 10, 12, and 14 inch diameters, with larger diameters available on special order. Each unit comes equipped with 8 feet of air hose and chain plus a stick holder for use with handle for easy insertion or removal from the pipe, and is fully guaranteed.

Underwriters' Label Now Available on Commercial Standard Septic Tanks

807

Vega Industries, Inc., San-Equip Div., Syracuse, N. Y., has announced that all San-Equip septic tanks built to Commercial Standard specifications, now carry the Underwriters Label that denotes factory inspection service by the Underwriters' Laboratories.

One Bright $ Sign in the Water Line

Most operations in the water processing line cost money . . . with little or no opportunity to make them pay for themselves.

One bright spot in the line is the water meter, which measures and determines the income. And when the meter is well set it can earn more by being well protected but still easily available for reading and changing.

Many water utilities are realizing thousands of dollars annually in labor savings and in increased revenues from well-set and well-maintained meters.

Perhaps you, too, can show bigger net profits this inexpensive way.

Send for
Ford Catalog No. 56.

THE FORD METER BOX COMPANY, INC.
Wabash, Indiana

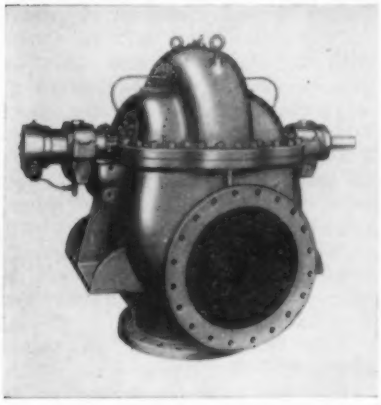
FOR BETTER WATER SERVICES FORD

This new provision for Underwriters' inspection and labeling of septic tanks built under Commercial Standard 177-51, was developed in cooperation with representatives of the U. S. Public Health Service, the American Public Health Assn., FHA and other federal and local agencies.

High Capacity Pumps For Severe Services

808

Goulds Pumps, Inc., Seneca Falls, N. Y. has introduced two pumps with capacities up to 25,000 GPM. These substantial pumps have performance characteristics to meet a wide range of applications. Both units are exactly the same except for the lower half casing. Fig. 3420 has horizontal suction and discharge, while Fig. 3423 has vertical bottom suction and horizontal discharge.



These single stage, double suction pumps have horizontally split casings with upper and lower half bolted and dowelled together. Removal of the upper half casing permits inspection, maintenance and removal of entire rotating element without disturbing suction and discharge piping or pump and driver alignment. The impeller is of the double suction type providing hydraulic balance. It is cast in one piece and all exterior surfaces are machined. It is dynamically balanced and keyed to the shaft. Interior surfaces or waterways are hand finished. All Fig. 3420-3423 pumps are fitted with renewable type casing wearing rings to maintain proper running clearance with impeller hub and to minimize leakage between suction and discharge chambers of casing. In addition, impeller wearing rings can be furnished when desired.

NOW...provide *COMPLETE* containment of water, wastes, brines and sludges with

SEALTIGHT **Hydromat** ASPHALT LINERS

Pre-fabricated "HYDROMAT" Asphalt Liners provide the ideal liner for all domestic, industrial and recreational facilities where the containment of water, wastes, sludges, brines, etc. demand a very efficient, economical and impervious lining material. "HYDROMAT" is quickly and easily installed as a monolithic liner with mechanically sealed joints . . will expand and contract with soil movements without rupturing or breaking the seal. Installed over (exposed) or under earth, concrete, gunite, steel or other materials... provides the practical answer to the problem of re-lining old, cracked concrete or gunite linings. "HYDROMAT" may be safely used for the containment of potable water in clear well construction and its ruggedness and durability permit its use as a fully exposed lining in large reservoirs to depths exceeding 50 feet. "HYDROMAT" is available in three thicknesses, ½", ¼" and 5/32", in 4' widths and lengths up to 15' . . . longer lengths available on special request.

For complete installation and technical data write today for your copy of the "HYDROMAT MANUAL".

SEALTIGHT PRODUCTS FOR BETTER CONSTRUCTION

W. R. MEADOWS, INC.

7 KIMBALL STREET
ELGIN, ILLINOIS

W. R. Meadows, Inc.
7 Kimball Street, Elgin, Illinois

Gentlemen:

☐ Send my copy of the "HYDROMAT MANUAL".

☐ Have representative call.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

Portable Pneumatic Sump Pump

809

Schramm, Inc., West Chester, Pa., has developed a portable pneumatic sump pump that can be admitted through extremely small openings (9 by 11 in.), and the flexible fire hose used for discharge can be wound around obstacles and passed through almost any opening. Any liquid over 1⅜ in. deep can be picked up. Dirty or clean liquids, as thin as water or as thick as sludge, are handled with ease.

The Borough of West Chester's sewage plant has found many uses for the new pump such as, clearing disposal tanks, sumps, manholes, blocked sewers, catch basins, pits and ditches, as well as cleaning residential cellers after flash floods.

The use of a portable pneumatic sump pump also eliminates the explosion hazard and other inconveniences experienced when a gasoline-driven, diaphragm-type suction pump was used.

The pump is carried and operated by the Pneumatractor, a self-propelled compressor. This has been found to be very useful (when not in pumping service) for other jobs such as hauling, sweeping, breaking out concrete, digging, grading, backfilling and tamping.

Honed Edge Pipe Cutter Wheel

810

Beaver Pipe Tools, Inc., Warren, Ohio, has announced that the new Beaver "Black Magic" Honed Edge Cutter Wheel is now the standard cutter wheel on the Beaver No. 2 Pipe Cutter, the Beaver Model-A Pipe Machine, and the Speed-O-Matic Pipe Machine.

The new Beaver "Black Magic" Cutter Wheel combines the easy-cutting quality of a thin wheel with the durability and long life of a heavy-duty wheel. The manufacturer claims that it cuts easier and lasts longer than either a heavy-duty or thin wheel. It fits all standard No. 2 pipe cutters and pipe machine cutoffs. The honed edge gives amazingly-easier, cleaner cuts; and the "Black Magic" finish process gives the wheel its magical cutting qualities, the manufacturer states.

The Beaver No. 2 threader places the cutting wheel directly behind the feed screw, and is fed directly into the work—thus contributing still further to easy cutting.

Cylindrical Slide Rule

811

Arthur F. Smith Co. Rochester, N. Y., has introduced for the first time in this country, a cylindrical calculator with an accuracy greater than slide rules currently on the market. The new calculator, by spiraling the scales around a tube instead of in a straight line, achieves graduations equal to those of a 66-inch slide rule.

Popular with engineers and scientists in England and Canada for a number of years, the cylindrical calculator may be used to solve all problems involving multiplication, division, proportion, percentages, logarithms, roots, and powers. The plastic-covered scales are fully resistant to wear and

ONE-MAN Relieved For Other Jobs by New AUTOMATIC BUCKET DUMPER

To get the full Automatic Bucket Dumper story, write for name of your nearest "Flexible" Distributor.

It's like having an extra man in your Sewer Department *at no extra cost.* The "Flexible" Bucket Dumper is a simple mechanical device that automatically does the job of the man *formerly required* to stand by the manhole and dump the bucket each time it came out of the sewer.

Costing less than 3 weeks wages, it can be installed in 30 minutes on all existing "Flexible" Bucket Machines. And, of course, you should get the facts before buying new machines.

(Distributors in Principal Cities)

FLEXIBLE INC.
3786 Durango Ave., Los Angeles 34, Calif.

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808	809	810	811	812	813	814
815	816	817	818	819	820	821
822	823	824	825	826	827	828
829	830	831	832	833	834	835

IF YOU WISH TO RECEIVE FURTHER INFORMATION ON PRODUCTS ADVERTISED OR REFERRED TO IN THE ARTICLES, OF THIS ISSUE—LIST THE PAGE NOS. BELOW.

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moisture, and since all parts of the instrument are made of metal throughout, there is no possibility of warping or distortion usually found after a time in wooden slide rules.

Though the instrument can be opened to 10¼" by 1¼", its size when closed is only 6" by 1¼", perfect for carrying in the pocket. It is almost indestructible, with no parts to break or loosen, and will last for a lifetime of normal use.

Emergency Kit Repairs Pipes, Tanks, Machinery

812

Devcon Corp., Danvers, Mass., has developed a new emergency repair kit containing Plastic Steel, for on-the-spot repairs of tanks, pipes, pumps, valves and other types of machinery without the use of special equipment.

Plastic steel is a combination of 80% steel and 20% plastic. It can be formed into any shape and will not run or sag when applied to a vertical surface. Two hours after the addition of a special hardening agent, Plastic Steel becomes an extremely strong, tough, rigid metallic piece. It is durable, permanent, essentially non-shrinking or expanding, does not rust and will harden under water.

Plastic Steel will harden in 60 seconds or less if heat is used. The following procedure should be followed to repair a large break in a water main. Shut off the water, and dry and clean the surface thoroughly. Heat the pipe with a blow torch so that it is just barely too hot to touch. Apply Plastic Steel to the pipe and then warm the top surface of the Plastic Steel slightly with the blow torch. Plastic Steel will be hard almost immediately. The main valve can be re-opened.

Laminations of glass tape and plastic steel have a compression strength of over 50,000 psi, and a tensile strength of over 45,000 psi.

E. R. P. CATHODIC PROTECTION . . .

individually designed for each application

An effective installation that operates at the lowest cost per year requires experienced engineering evaluation of site and environmental conditions. The Electro Rust-Proofing Engineering Division makes available to you the cumulative experience gained in designing more than 10,000 cathodic protection systems.

Electro Rust-Proofing can furnish any one, or all, of the following services to help you provide proper cathodic protection for each of your jobs:

- Corrosion surveys and recommendations
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- Cathodic protection equipment and installation
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For additional information write today.

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E-35R

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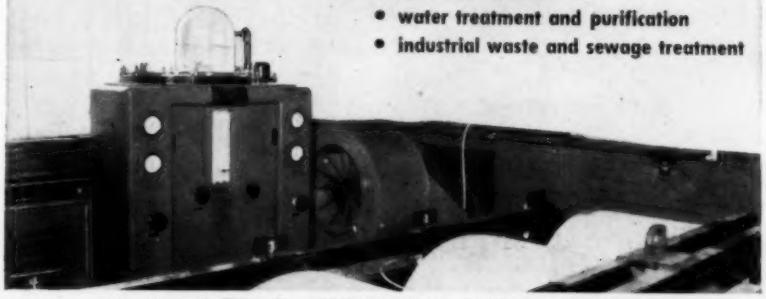
for • slime elimination
• water treatment and purification
• industrial waste and sewage treatment



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Meet AWWA Specifications C 504-55T . . .

LEOPOLD
Rubber Seated
BUTTERFLY VALVES

with exclusive valve seat design that assures added firmness, increased rigidity, and permanent concentricity of seat to valve body!

In the Leopold construction, there's no possibility of abnormal wearing of the valve seat—a common cause of valve failure. That's because the seat is of pure gum rubber or resilient neoprene vulcanized around a *continuous steel ring insert.* Thus, Leopold Valves last longer and always provide positive drop-tight shut-off. Available in sizes 6″ to 96″ with manual or automatic controls.

Write for details!

Leopold
F. B. LEOPOLD CO., INC.
Zelienople, Pa.
Complete Water Purification and Filter Plant Equipment

Variable Flow Rate Pump-Motor Set

813

Vanton Pump & Equipment Corp., Hillside, N. J., has developed a variable flow rate pump-motor set designed for applications where controlled and varying rates of flow of corrosive fluids and abrasive slurries are required.

With the pump driven by a variable speed source, a relatively linear relationship between speed and output can be obtained, according to Vanton, which maintains that varying the speed of the driver in this way offers a practical and exact way of varying the rate of flow.

Several means of obtaining variable speeds are provided. One is a simple hand operated variable pitch pulley arrangement. Another is an integral variable speed motor drive in which provision is made for automatic process control by using an air cylinder to set the RPM of the variable speed drive. The pumps are self priming and flow rates from fractional to 40 GPM are available.

"Liquid Wrench" Now In Spray Can

814

Radiator Specialty Co., Charlotte, N. C., has announced that "Liquid Wrench," penetrating rust solvent, is now available in handy 12-oz. pressurized squirt cans.

The new squirt can makes it easy to apply liquid wrench to "hard-to-reach" areas.

"Liquid wrench" is a blend of fast-acting, super-penetrating solvents that free parts frozen by rust, corrosion, scale, paint, varnish or gum. It is harmless to metals.

For Municipal Water
FLUORIDATION

You get three-way economy, safety and assurance of ample supplies with

INTERNATIONAL HYDROFLUOSILICIC ACID

Municipalities save three ways with *International Hydrofluosilicic Acid:* in cost of equipment installation, in operating cost and in cost of materials. Handling and control of liquid feed is simple and easy with a minimum of space needed for storage.

Liquid feed assures maximum safety for operating personnel.

International Hydrofluosilicic Acid is available for immediate delivery in tank truck and tank car deliveries.

Shipments are currently being made from plants at Mason City, Iowa; Chicago Heights, Illinois; Lockland (Cincinnati), Ohio; Buffalo, New York; East Point, Georgia; Hartsville and Spartanburg, South Carolina and Tupelo, Mississippi. Other shipping locations will soon be available.

With ample raw materials and large production facilities, *International* can provide municipalities with a dependable source of supply today and in the years ahead.

International Hydrofluosilicic Acid runs typically 23% to 25% H_2SiF_6.

If you are fluoridating now or planning to do so soon, it will pay you to talk with *International's* representative about the use, handling and costs of *Hydrofluosilicic Acid.* Please write or phone the office near you.

International MINERALS & CHEMICAL

INTERNATIONAL MINERALS & CHEMICAL CORPORATION
POTASH DIVISION
20 North Wacker Drive, Chicago 6
485 Lexington Ave., New York 17
Midland, Texas
Fulton National Bank Bldg., Atlanta, Ga.

Air Lift Pumps For Low Lift Applications

815

Walker Process Equipment Inc., Aurora, Ill., has introduced a new complete line of Aeropumps. These air lift pump units, designed specifically for low lift pumping applications, are offered in eight sizes from 3 thru 16 inches. According to the manufacturer, Airopumps feature more efficiency at less operating, maintenance and installation cost, as compared to centrifugal pumps when pumping against heads of less than 4 ft., and equal efficiency when pumping 4½ ft.

Prior air lift pumps were patterned after the high lift designs and by hit-and-miss sizing and detailing, and generally proved unsatisfactory and inefficient. In completely developing the low lift Airopump line, Walker has demonstrated that these units offer many advantages and are efficient when properly designed and applied.

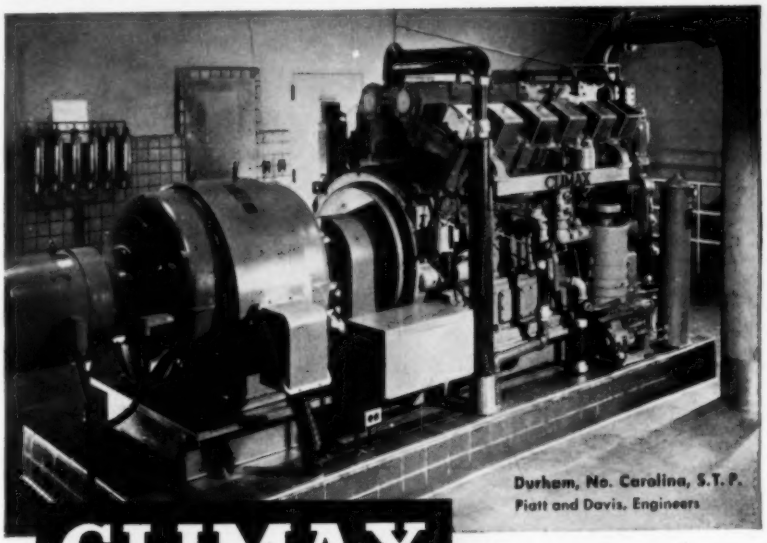
Improved Gage Glass Cleaning Tool

816

Jerguson Gage & Valve Company, Burlington, Massachusetts, has announced an Improved Design Gage Glass Cleaning Tool which uses brushes to quickly and efficiently clean the inside of liquid level gage glasses. This new cleaning tool is simple and effective, with no critical parts to break down. The brushes are easily replaced, and are economical.

The cleaning tool consists of a stainless steel rod with a bronze T handle, operating inside a stainless steel tube. The wiping mechanism consists of two commercially available brushes which screw into a holding plate. These brushes are far superior to other wiping materials because they increase the life of the unit and also allow effective cleaning to the very ends of the visible glass of the gage.

The tool is inserted into the gage with the brushes vertical. With the handle held in position, the tube is pulled down against a spring and rotated 180°. Releasing the tube then locks the brushes in a horizontal position ready for cleaning the glass.

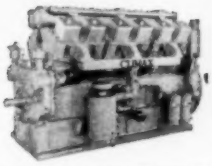


Durham, No. Carolina, S.T.P.
Platt and Davis, Engineers

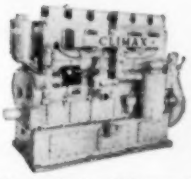
CLIMAX
POWER
FOR SEWAGE TREATMENT PLANTS...

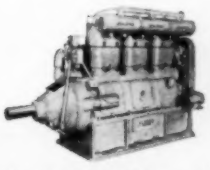
Climax engines can be found on the job every day of the year in hundreds of sewage treatment plants from coast to coast—powering sewage pumps, blowers and generators. Tremendous savings are being realized by using readily available **sludge gas** for fuel and also by utilizing heat from the jacket water and exhaust gas of the engines to heat digesters and buildings. When a shortage of sludge gas is encountered these engines operate on an auxiliary fuel—either gasoline, butane or natural gas, or a combination thereof. Eight Climax engines are available for continuous duty service in Sewage Plants in a range of sizes from 40 to 300 hp.—for standby service up to 605 hp. max. rating.

Write today for complete information, bulletins or engineering consultation.


V-125—12 cylinder, 605 max. H.P. at 1200 R.P.M.
V-122—12 cylinder, 520 max. H.P. at 1200 R.P.M.

V-85—8 cylinder, 390 max. H.P. at 1200 R.P.M.
V-80—8 cylinder, 340 max. H.P. at 1200 R.P.M.


K-75—6 cylinder, 302 max. H.P. at 1200 R.P.M.
K-67—6 cylinder, 265 max. H.P. at 1200 R.P.M.


R-165—6 cylinder, 192 max. H.P. at 1200 R.P.M.
R-110—4 cylinder, 130 max. H.P. at 1200 R.P.M.

CLIMAX ENGINE MANUFACTURING CO.
208A South LaSalle Street • Chicago 4, Illinois
Factory—CLINTON, IOWA • District Office—DALLAS, TEXAS

W&SW

Manufacturers' News

Changes in U. S. Pipe Sales Dept.

United States Pipe and Foundry Company, Birmingham, Ala., has announced the following sales department personnel changes:

Appointment of George J. Bogs, formerly Los Angeles Sales Agent, as Assistant Pacific Coast Sales Manager. Mr. Bogs was associated with the Chicago Office from 1946 until 1954 when he was appointed Sales Agent at Los Angeles. In his new capacity he will continue to make his headquarters in the Los Angeles Office.

Appointment of Bartlett G. Bretz, currently Kansas City Sales Agent as Assistant Western Sales Manager with headquarters in the Chicago Office. Mr. Bretz has been connected with the Kansas City Office since 1947 and has been Sales Agent since 1952.

Appointment of Buddy P. Amis, currently in charge of the Houston Office, as Kansas City Sales Agent. Mr. Amis started in the Dallas Office in 1947 and took over the Houston Office in 1954.

Hoyt N. Burns, previously connected with the Birmingham Office, has been appointed Sales Agent at Houston.

Huiett Appointed Sales Manager of Kenco Pump

Kenco Pump Division, Lorain, Ohio has announced the appointment of James G. Huiett as sales manager.

Mr. Huiett, formerly service manager for Kenco Pump Division, has been directly involved with the service and sale of Kenco pumps since 1950. He will be in charge of sales and service for the complete Kenco line of submersibles.

Gladding, McBean Appoints Hennessy

Gladding, McBean & Co., Los Angeles, Calif., has announced the appointment of Mr. Paul V. Hennessy as a civil engineer with the Pipe Products Division.

Mr. Hennessy is a graduate of the University of Southern California with a B.S. degree in civil engineering. Active in association affairs, he is chairman of the Los Angeles chapter of the ASCE sanitary group, a member of the CSIWA and the Arizona Sewerage and Water Works Association. During World War II, he served as an aviator in the Naval Air Corps.

Prior to his appointment, Mr. Hennessy was manager of B.I.F. Industries' Southern California-Arizona division. He will make his headquarters in Gladding, McBean's San Francisco office.

PHOTOVOLT
pH Meter MOD. 115

A full-fledged line-operated pH Meter of remarkable accuracy at the unprecedented price of $130.-
(complete incl. electrodes)

Write for bulletin # 225 to

PHOTOVOLT CORP.
95 MADISON AVE NEW YORK 16, N. Y.

(*Continued from page 95A*)

Oct. 28-30—Toronto, Ontario (*King Edward Hotel*)
CANADIAN INSTITUTE ON SEWAGE & SANITATION, Secy., Dr. A. E. Berry, Administrative Office, 72 Grenville St., Toronto, Ontario, Canada

Oct. 29—Nov. 1—San Jose, Calif. (*Civic Auditorium*)
CALIFORNIA SECTION, A.W.W.A., Secy., Henry J. Ongerth, Bureau of San. Engr., 905 Contra Ave., Berkeley 7, Calif.

Oct. 30-Nov.1—Washington, D. C. (*Sheraton-Park Hotel*)
CHESAPEAKE SECTION, AW.W.A., Secy., Carl J. Lauter, 6955—33rd St., N.W., Washington 15, D. C.

Nov. 6-8—Roanoke, Va. (*Hotel Roanoke*)
VIRGINIA SECTION, A.W.W.A., Secy. J. P. Kavanagh, District Manager, Wallace & Tiernan, Inc., 213 Carlton Terrace Bldg., Roanoke, Va.

Nov. 7-8—Hastings, Neb. (*Clark Hotel*)
NEBRASKA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., V. J. Lechtenberg, 614 Standard Oil Bldg., Omaha, Neb.

Nov. 10-13—Jacksonville, Fla. (*Roosevelt Hotel*)
FLORIDA SECTION, A.W.W.A., Secy., Jay D. Roth, Mgr., Water Dept. & City Shops, Bin O, Miami Beach 39, Fla.

Nov. 11-13—Raleigh, N. C. (*Hotel Sir Walter*)
NORTH CAROLINA SECTION, *A.W.W.A.*, AND NORTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSN., Joint Meeting, Secy. Wilbur E. Long, Jr., 1615 Bickett Blvd., Raleigh, N. C.

Nov. 11-15—Cleveland, Ohio
AMERICAN PUBLIC HEALTH ASSOCIATION, 85th Annual Meeting, Exec. Director, Dr. Reginald M. Atwater, 1790 Broadway, New York 19, N. Y.

Nov. 18-22—Stillwater, Okla. (*Oklahoma A & M College*)
OKLAHOMA WATER & SEWAGE SHORT COURSE, Prof. Quintin B. GRAVES, Oklahoma A & M College, Stillwater, Okla.

Nov. 21—Boston, Mass. (*Hotel Statler*)
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

Estus Named Sales Manager For Hersey

Hersey Manufacturing Co., South Boston, Mass., has announced the appointment of Ralph S. Estus as sales manager for the company.

Mr. Estus joined the Hersey organization in 1955 after being associated with the Fuller Brush Co., as manager of industrial sales. Prior to that he was associated with the Armstrong Cork Co., and the Prudential Life Insurance Co.

He is a graduate of the Wharton School of Business Administration, University of Pennsylvania.

Bower Named Clow Sales Manager

James B. Clow & Sons, Inc., Chicago, Ill., has announced that Harry F. Bower has been named Manager, Cast Iron Pipe and Foundry Department. In this capacity, Bower succeeds, V. M. Wall, who is retiring.

Bower, formerly assistant manager, has also acted as Director of Sales, Eddy Valve Company, Waterford, New York, and the Iowa Valve Company, Oskaloosa, Iowa, both subsidiaries of Clow. In 1955 he served in an industrial capacity as Director, Water and Sewerage Division, Business and Defense Services Administration, Department of Commerce.

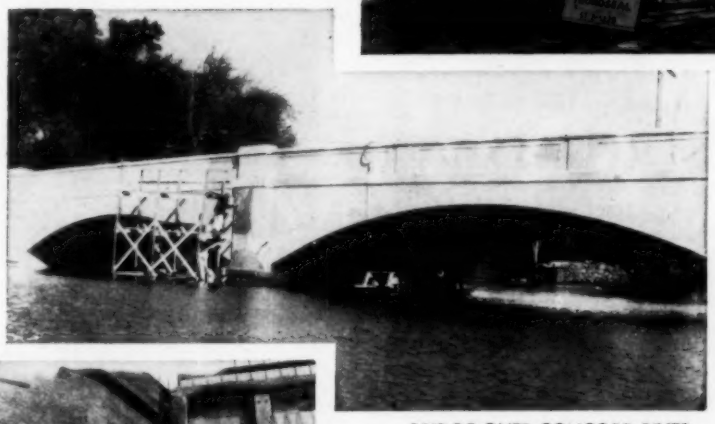
F & P To Market Gilbarco Tank Gauge

Fischer & Porter Co., Hatboro, Pa., has announced that they have become sales agent of the Gilbarco Electronic Tank Gauge. In addition, Fischer & Porter will take over the manufacture of the Gilbarco Null Balance Tank Level Receiver, which, combined with the F & P Digital Data Systems, will provide a complete tank gauging and digital readout system.

The Gilbarco electronic tank gauge is manufactured by Gilbert & Barker Company, West Springfield, Mass.

It's New Again with THORITE and THOROSEAL

Freeze-thaw cycle following water and moisture penetration, also swelling of reinforcing rods from moisture contact, cause masonry destruction.



BRIDGE OVER CONCORD RIVER
ROUTE 3, BELLERICA, MASS.

Workmen on scaffold patch spalled and cracked concrete with THORITE and seal surface with THOROSEAL.

Area at left chipped to sound masonry. It will then be patched with THORITE *Nonshrink, Nonslump 20-Minute Set Patching Mortar*, without necessity of costly forming, finished by application of Thoroseal.

Request Circular No. 16 and 20.

Write for our 16 page "How to Do It"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA • CENTERVILLE, INDIANA

M-H Names Water Industry Sales Manager In East

Minneapolis-Honeywell Regulator Company's Industrial division, Philadelphia, Pa., has announced that Frank L. Mascitti has been appointed sales manager for the Water & Wastes Treatment industry.

Mascitti, who will cover the regions east of the Mississippi river, joined the firm seven years ago as a sales engineer. He has specialized in the water and wastes treatment industry for the division as industry engineer.

Mascitti will make his headquarters in the Industrial division's main plant in Philadelphia.

Mohan Joins Milton Roy

The Milton Roy Company, Philadelphia, Pa., has announced the appointment of Alfred E. Mohan, 1266 South Newkirk Street, Philadelphia, to their Sales-Engineering staff.

A graduate of Villanova University in 1954 with a degree in Chemical Engineering, he served over two years in the U. S. Navy as a Ship's Engineering Officer. Prior to military service, he was employed at the Frankford Arsenal in polymer research and development.

Johns-Manville Promotes Davis

Johns-Manville Corporation, New York, N. Y., has announced the appointment of Jack W. Davis, 10370 W. 13th Place, Lakewood, Colo., as regional sales manager for the Pipe Division.

The newly established region will encompass the states of Colorado, Idaho, Montana, New Mexico and Wyoming.

Prior to joining Johns-Manville in 1944 as district engineer for the Denver district, Mr. Davis was associated with the United States Public Health Service and the Colorado State Board of Health. In 1947 he was appointed Johns-Manville manager for Transite pipe at Denver.

Bristol Moves Pittsburgh Headquarters

The Bristol Company, Waterbury, Conn., has announced that its Pittsburgh, Pennsylvania district office has recently moved into a new building at 2250 Noblestown Road.

The new building will house the sales and service staffs, and the new and larger facilities will improve handling of customer requirements.

V. L. Greedy Joins Pipe Linings, Inc.

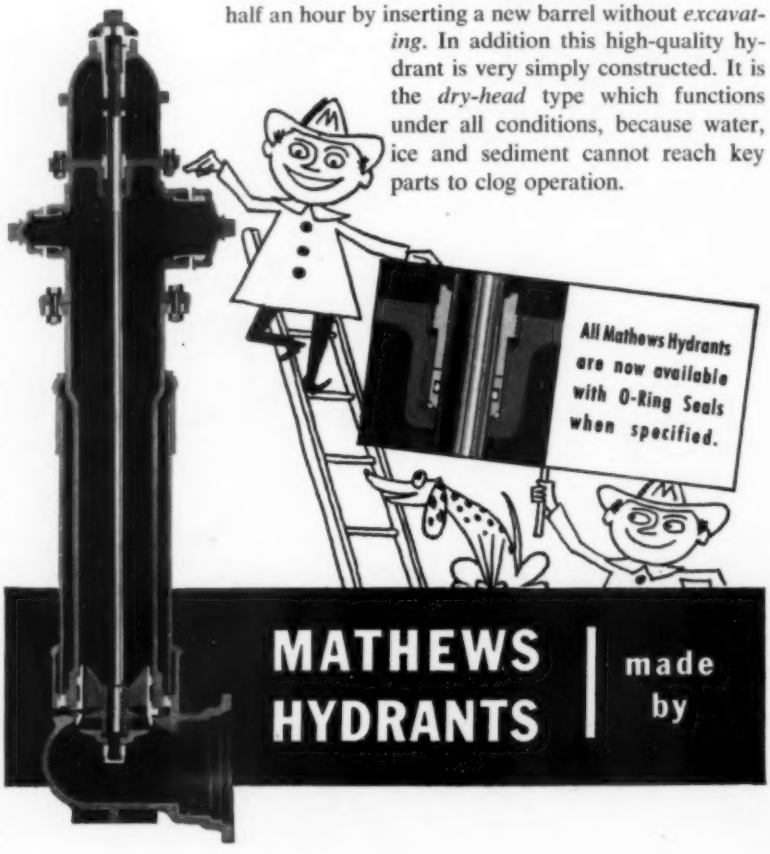
Pipe Linings, Inc., Los Angeles, Calif., has announced the appointment of V. L. Greedy to the position of sales manager for the company.

Mr. Greedy, prior to joining Pipe Linings, was district sales manager for American Pipe & Construction Co. He received a degree in engineering from the University of Washington and is a veteran of World War II and the Korean conflict.

The name MATHEWS means the

THE MATHEWS MODERNIZED HYDRANT

The hydrant with the *replaceable* barrel. A Mathews broken in a traffic accident can be repaired in less than half an hour by inserting a new barrel without *excavating*. In addition this high-quality hydrant is very simply constructed. It is the *dry-head* type which functions under all conditions, because water, ice and sediment cannot reach key parts to clog operation.



MATHEWS HYDRANTS | made by

Roots-Connersville Opens Boston Office

Roots-Connersville Blower, Connersville, Ind., Div., Dresser Industries, Inc., has established a Boston district sales office at 945 Great Plain Avenue, Needham 92, Massachusetts. Telephone—NEedham 3-2322.

According to the announcement George F. Varga will head the new office. Varga will assume responsibility for the organization and management of the Boston sales territory which includes Massachusetts, Rhode Island, Vermont, New Hampshire and Maine.

A mechanical engineering graduate of Duke University, Varga has more than fifteen years experience selling engineered equipment to industry. For the past five years he has worked as a Field Engineer in Roots-Connersville's New York district office.

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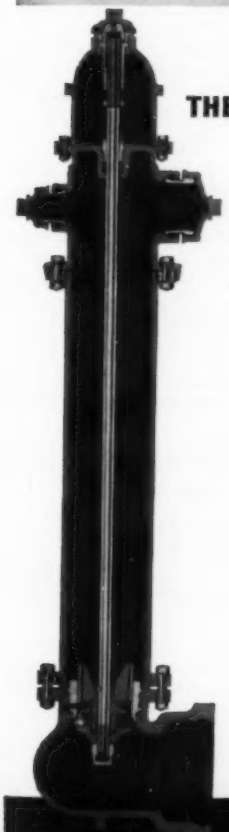
finest in fire protection



THE MATHEWS FLANGE BARREL HYDRANT

Another dry-head hydrant in which the stuffing box plate is cast integral with the nozzle section. The top section of this hydrant incorporates all features of the Modernized Mathews. As an optional feature furnished at slight extra cost, it is supplied with a breakable flange and stem coupling designed to snap when struck a heavy blow. These parts can be quickly replaced without excavating.

All available with mechanical joint and flange-type connections

R. D. WOOD CO.

Public Ledger Building, Independence Square • Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

Darling Valve Promotes Backus

Darling Valve & Manufacturing Co., Williamsport, Pa., has announced the appointment of Foster E. Backus to the position of Mid-West Regional Sales Manager.

In his new position, Mr. Backus will supervise sales activities in the 13-state area from Western Pennsylvania to the Dakotas and south to Kentucky. He will headquarter at 1513 Jefferson Ave., Toledo, Ohio. Mr. Backus is a native of Toledo, was educated there and at Ohio State University, and served four years in the U. S. Air Corp during World War II.

M-C-G Co. To Handle Sales & Distribution Of Techno Check Valves

M-C-G Company, Columbus, Ohio has announced that all sales and distribution of the Techno check silent seatless check valves, are now being handled by the company.

The Technocheck valve design gives positive automatic opening and closing on low pressure differential. The design eliminates the need for valve seats. It utilizes the valve body for this purpose and thus keeps replacement parts and maintenance costs to a minimum.

First Jeffrey Factory School

The first Factory School for authorized distributors has been held by The Jeffrey Manufacturing Company's Industrial Division at the Columbus, Ohio plant. This inaugural session for 1957 was attended by 16 key men for the three-day training on Jeffrey merchandise, crushers and vibrating equipment. Certificates, of achievement and completion awards were presented to the students by J. E. M. Wilson, vice president in charge of sales, at the graduation dinner. This presentation followed a humorous talk by Mack Sauer, well-known philosopher and editor of the Leesburg, Ohio Citizen.

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New Literature

Plastic Pipe Catalog

817

Orangeburg Manufacturing Co., New York, N. Y., has just published a catalog on the development, application, installation and specifications of **Orangeburg SP Plastic Pipe.**

According to the catalog, the pipe, made from a recently developed, superior, new-type polyethylene resin, displays working pressures, heat resistance, absence of pin holing and resistance to chemicals superior to any polyethylene pipe yet produced.

pH Electrodes

818

Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif., has just published an 8-page bulletin featuring **Beckman pH Electrodes** for laboratory and portable pH meters.

The bulletin is made up in simplified chart-form, completely indexed and illustrated, and provides a guide for users in selecting the correct pH electrodes.

This new version is one of a five-bulletin package which also includes information on the Zeromatic, Pocket pH, and other Beckman pH meters.

Air Valve Catalog

819

Multiplex Manufacturing Company, Berwick, Pennsylvania has announced that the new **Crispin Air Valve Catalog** is ready for distribution.

Included in this new, 2-color, 28-page, fully illustrated catalog are basic facts on the complete line of Crispin Valves used in the water, sewage and process industries. Complete specifications, useful charts and operating data on all products are given together with parts—list information for the Crispin Air and Vacuum, Pressure Air and Universal Air Valves. In addition, there is a special section on Crispin Slip Joints and Compressors. "How to Order" and "Where to Buy" facts that are a part of this new, 2-color catalog, should prove valuable.

Factory-Made Clay Pipe Joints

820

The Logan Clay Products Co., Logan, Ohio, has just released an attractive, new brochure, that illustrates and describes its complete line of **Factory-Made Clay Pipe Joints.**

The full-color brochure lists specific uses for clay pipe, with emphasis on Logan's Wedge-Lock, Slip-Joint and King-Size clay pipe. According to the brochure, Logan factory-made Wedge-Lock and Slip-Joint clay pipe joints provide fast, easy installation, while King-Size clay pipe, in lengths up to five feet, cuts installation and labor time by as much as 50 percent.

Chemical Relief and Back Pressure Valves

821

Milton Roy Company, Philadelphia, Pa., has just published a new bulletin describing their line of **Chemical Relief Valves and Back Pressure Valves.** The 4-page, two color bulletin gives complete specifications including capacities of four standard sizes—¼, ½, ¾, and 1-inch. Dimensions and materials of construction are also included.

Relief valves are used with corrosive liquids to 1500 psi, and back pressure valves are used to pressure 200 psi. Topworks of both valves are protected by Kel-F or Teflon diaphragms.

Extra-Strength Clay Pipe

822

The Clay Sewer Pipe Association, Inc., Columbus, Ohio, has released a new 4-page technical bulletin on **Extra-Strength Clay Pipe.**

The bulletin illustrates pipe trenching conditions which require extra-strength pipe, and contains detailed tables of safe supporting strengths for both extra-strength and standard strength clay pipe. The tables give supporting strengths in pounds per lineal foot for pipe sizes from 6 to 36 inches and for varying bedding conditions.

The bulletin also lists crushing strength requirements for extra-strength clay pipe and schedules of dimensions for full-diameter and reduced-diameter extra-strength pipe.

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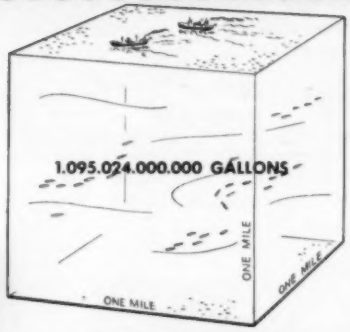

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Safety "Check List" For Explosion Hazards

823

Crouse Hinds Company, Syracuse, N. Y., has available a "**Hazard Finder**", to locate the hidden probabilities of electrically ignited explosions in plants.

This 8-page, illustrated folder contains a check list of 13 questions that can help determine whether uncontrolled flammable gases, vapors, dusts, liquids and other combustible materials are making the plant unsafe. Part of the folder is sealed until all the questions have been answered. After seal is broken, an evaluation of the hazard potential in the plant is revealed, based on the answers and the findings of the National Fire Protection Association.

"Blue Book" on Electric Generating Plants

824

D. W. Onan & Sons Inc., Minneapolis, Minn., has revised their "**Blue Book**" of general information concerning the selection of engine driven electric generating plants. The pocket sized booklet traces the history of electric plant development from early stages where storage batteries were necessary to today's modern single-unit, engine-generator power plants.

Described in simple, easy-to-understand language are the three general groups of electric plants: Alternating Current (A.C.), Direct Current (D.C.) and Battery Charging. Plant operation for each type is thoroughly discussed.

The booklet reviews the three types of prime mover which furnishes the mechanical power for driving the generator, namely: Gasoline Engine, Diesel Engine and Gas Engine. Cost of operation and installation of each type is discussed. Differences of engine cooling are compared, starting methods are described and a concise summary of important points to remember in selection of an electric generating plant is also included.

Floatless Transmitter For Parshall Flume Flows

825

The Foxboro Company, Foxboro, Mass., has just released an Application **Engineering Data Sheet** describing a new system for transmitting water or waste flow measurement from a Parshall flume to a flow recorder.

As diagrammed, the system consists of a Foxboro d/p Cell Transmitter which senses back pressure in a bubble tube inserted in the float well. The output of the transmitter is received by a pneumatic receiver-recorder. A special chart which incorporates the exponents of the flow equation enables flow to be read directly in flow units. An installation drawing showing the instrumentation of the system is also included.

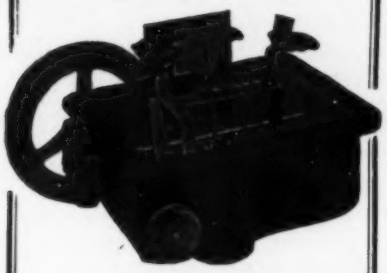
Clay Pipe Joint Sealant

826

The Superior Clay Corporation, Uhrichsville, Ohio, has just published a 4-page brochure, illustrating and describing applications of the new **PT Clay Pipe Joint Sealant.**

The 2-color brochure contains photographs illustrating actual "on-the-job" installations of vitrified clay pipe using PT 75, including under-water installations, "pea soup" trenches, well point trenches, and in cramped quarters. The simple, time-saving, three-step method of applying the joint sealant for tight joints under all trench conditions also is detailed.

ROTO-TROL



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This 2-pump RF-2 Roto-Trol assures equal use and wear of both pumps. Each pump is operated on alternate starting cycles.

The RF-2 operates both pumps together, when required. RF-2 installations give dependable service year after year, with the minimum of attention.

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Write for Circular and Price List No. 35WS

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Wedge-Lock Clay Pipe

827

Robinson Clay Product Co., Akron, Ohio, has published a new brochure for engineers, architects, builders, contractors, plumbers, and public officials on **Wedge-Lock Clay Pipe.**

Completely illustrated, this 2-color, 4-page, file-size brochure offers complete information on the time-tested qualities of vitrified clay pipe with the new factory-made Wedge-lock plastic joint that snaps together instantly.

The brochure also details the mechanics of Wedge-Lock's total-contact joint, illustrates the simple installation procedure, and describes clay pipe fittings available in diameters from 4 to 15 inches.

Automatic Controls in Filter Plants

828

Builders-Providence, Inc., a division of B-I-F Industries, Inc., Providence, R. I., has available an 8-page bulletin on **Automatic Controls in Filter Plants** written by Milford E. Rigers, Mgr. Project Sales.

The article describes "automation" as it applies to hydropneumatic control, automatic backwash control, backwash rates, air transmission, control variations, and the benefits and future use of this type of control. The bulletin is well illustrated with diagrammatic drawings and photographs of actual installations.

Design And Specification of Watertight Masonry

829

The Master Builders Co., Cleveland, Ohio, has just published a 6-page folder on the subject of **Design and Specification of Watertight Masonry.**

This bulletin discusses the important elements involved in the construction of watertight masonry, and cited good workmanship and lack of cracks between brick and mortar as the principal pre-requisites to watertight masonry. It also outlines six considerations in designing tight masonry walls.

Discussion covers: mortar ingredients and proportioning; compatibility of brick and mortar; control of shrinkage and bleeding; separation cracks; effect of mechanical disturbance; and the importance of proper protection.

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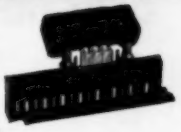

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Corrosion Tester
830

Labline, Inc., Chicago, Ill., just published a new 16-page brochure on the Labline-Pure **"Corro-Dex"** for determining rates of corrosion.

The brochure describes two models, line-operated, and portable battery-operated. Also discussed are probes of all types, such as steel, nickel, monel, copper, brass, aluminum, lead, etc.

According to the brochure "Corro-Dex" applies A.C. current to probes and eliminates all polarization and side effects. Portable field model "Corro-Dex" has single knob control.

Plug Valve Lubricants
831

Homestead Valve Manufacturing Co., Coraopolis, Pa., has just released a 16-page book on **Homestead Plug Valve Lubricants.**

This informative book answers nearly 4000 questions about valve applications. Especially designed to save time, worry, and expense in choosing the right valves and lubricants for each set of service conditions, the book gives recommendations for nearly 1000 services within four different temperature ranges.

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"EVERYTHING FOR THE SWIMMING POOL"

Weigher For Belt-Conveyed Materials
832

Builders-Providence, Inc., a division of B-I-F industries, Inc., Providence, R. I., has just published a bulletin describing how any belt-conveyed dry material can be accurately, automatically, and continuously totalized and fed by the modified **Conveyoflo Meter.**

This 4-page bulletin describes the design features, principles of operation, and dimensional data about the meter, and shows processes and typical applications where it has improved product quality at reduced costs. The bulletin is profusely illustrated with photographs and simplified line drawings.

Rotameter Bulletin
833

Brooks Rotameter Company, Lansdale, Pa., has released a bulletin that utilizes a novel and convenient means for aiding prospective users of **Brooks Rotameters** in the selection of the appropriate meter for a specific application.

A die cut disc, eyeletted on the inside cover of the bulletin serves to indicate the pressure and temperature limitations of Brooks rotameters as well as their flow capacity ranges. The indicated meter in turn is tied into brief descriptions given on an opposite page with references to further detailed literature.

Centralized, Supervisory Control
834

Builders-Providence, Inc., a division of B-I-F Industries, Inc., Providence, R. I., has published a 12-page color bulletin describing the centralized, economical control of widespread, remote operations as accomplished by the **Synchro-Scan Supervisory Control System.**

The bulletin contains numerous illustration, diagrammatic and wiring drawings, and typical installation photos. It is laid out to show how this supervisory control system is developed from a simple to a more complex form. The bulletin also includes data on the various means of signal transmission possible, standard accessories, and other features contributing to its application versatility.

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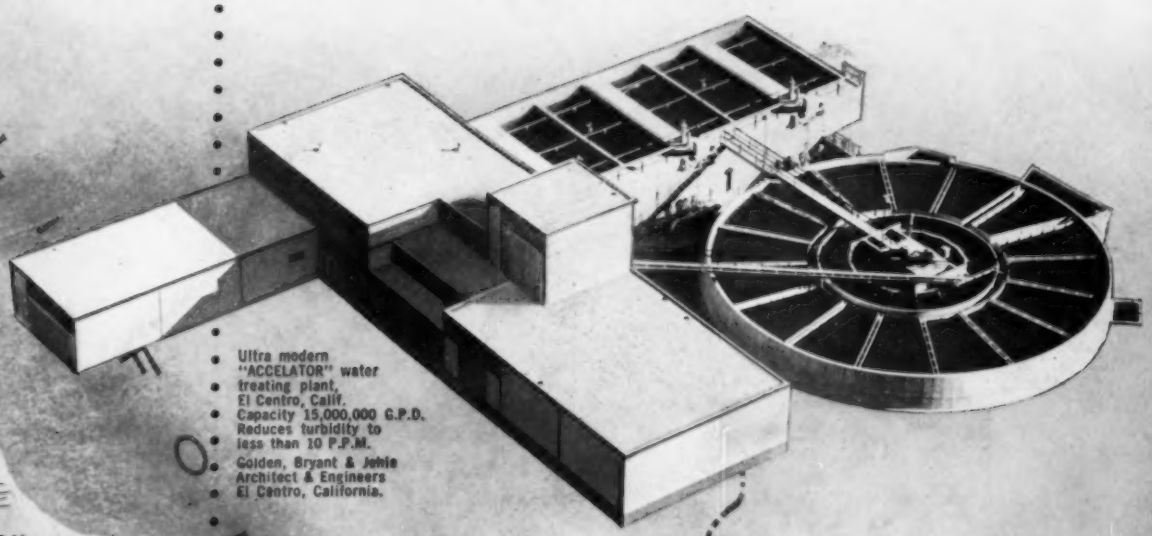

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